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ABSTRACT

This volume presents 30 conference papers: (1) "Empowering the Workforce to Improve Efficiency and Responsiveness" by Marilyn Lockhart and others; (2) "Teamwork: Leadership Not Pushership" by Polly Pinney; (3) "Training: A Continuing Process" by Thomas F. Vacha; (4) "Presupervisory Training: Less Talk, More Action" by Jim Davis and Paul Schneller; (5) "Performance Evaluations: A Positive Experience" by Katie Smothers; (6) "There Is a Dual Purpose in Motivation" by George B. Wright; (7) "APPA Study-Custodial Staffing Guidelines" by Kirk Campbell and others; (8) "Managing Roofs: A Case History at Oregon State University" by Richard L. McBride and John L. Stephens; (9) "Single-Ply Roofs: Eight Years Later" by Dennis P. Cesari; (10) "Institutional Waste Management" by Edward C. Bogard; (11) "Managing at the Small College: Being Greater With Fewer" by Charles W. Jenkins; (12) "An Asbestos Abatement Project: Learning the Hard Way" by Ken C. Fay; (13) "Yes! We Dó Windows: How to Select/Manage A Contract Maintenance Firm" by Edward L. Smith; (14) "Contracting for Trades Services" by Patrick J. Lawlor; (15) "Enhancing the Physical Plant Administrator's Image by Writing Technical Papers and News Articles" by John D. Rulfs and Sherry L. Rulfs; (16) "Unique Approaches to Marketing the Physical Plant Organization" by Robert H. Clawson; (17) "Forestalling Complaints in Physical Plant Administration" by Edwin B. Feldman; (18) "Deferred Maintenance and Self-Evaluation" by Henry L Shelby; (19) "Predicting Maintenance Resources for New and Existing Facilities" by Robert Neathammer and Edgar S. Neely; (20) "Design Approaches to Special Challenges of Academic Facilities" by Robert B. Brandt and Leevi Kiil; (21) "Construction Cost Managment in the Public Sector" by Charles F. Dahill, and others; (22) "The Computer: A Work Load Management Tool that Works" by Kenneth G. Smith; (23) "Automating Plant Maintenance Pay Off: Myth or Reality" by Keith E. Burres; (24) "Integrated Information Systems for Facilities Management" by Lothar Herrman and Mohammad H. Qayoumi; (25) "An Automated Mapping and Facilities Management System" by Jim Baker and others; (26) "TRACKER: A Data Entry and Reporting System" by Lee V. McQueen; (27) "Evaluating Boiler Useful Life for Project Planning" by James R. Myers; (28) "Cooling Tower: The Neglected Orphan" by Robert Burger; (29) "Free Cooling: How and Why" by Michael J. Dwyer, Jr.; and (30) "Utilities Infrastructure Development at a Major Research University" by Brad Purinton and John R. Swistock. Some papers contain references. An appendix lists annual meeting speakers. (JB)

76TH

ANNUAL & MEETING

FOUNDERS CELEBRATION

75 Years of Service

Proceedings of

The Seventy-Sixth
Annual Meeting of
The Association of
Physical Plant Administrators
of Universities and Colleges

July 16-19, 1989 • Reno, Nevada

Vice President for Educational Programs:
William D. Middleton, University of Virginia

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76TH
ANNUAL MEETING
FOUNDERS' CELEBRATION

Developing Employee and Supervisor Skills

Middleton

Empowering the Workforce to Improve Efficiency and Responsiveness

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I. **DESCRIPTION OF THE PROBLEM** (William D. Middleton)

The three of us will be discussing this morning a people-oriented program called "Service Excellence" that has become a major component of our efforts to enhance the overall quality of the services we provide, and our users' perceptions of the quality of that service.

The problems that led us to initiate this program will be familiar ones to all of you. Ours is a typical large university physical plant organization, providing an exceptionally broad range of services, from custodial care to planning and construction of new facilities.

We provide a broader range of services than any other campus service organization by far.

We provide services to -- in effect -- more members of the campus community than any other campus service organization, and with perhaps more direct "customer contact" than just about any other such organization.

Above all, we are a service organization.

I believe, and I am sure that most of you believe of your organizations, that the people who manage and deliver these physical plant services are highly qualified in the performance of their jobs. They do a good job, and they do it efficiently.

A great many of our campus customers recognize this, but all too often we find that:

- o good service is taken for granted.
- o we only hear from our customers when something has gone wrong, or is perceived as having gone wrong.

There is always a certain amount of "background noise" of grumbling about physical plant services:

- o it takes too long,
- o it costs too much, or
- o physical plant is a giant bureaucracy that we don't how to penetrate.

It was with this sort of a universal physical plant problem in mind that we conceived our Service Excellence program.

We didn't believe that performance itself was the problem, and we felt it was important that we tell our people that at the very beginning of the program.

We did believe that there was substantial room for improvement in the way that that performance was delivered, and in the way that we managed the delivery of these services.

What we wanted to do was to build into the entire organization a service orientation, a service attitude, that would really get at these problems.

I believe that I myself have a genuine service orientation and I believe that the great majority of our senior managers have one too. The real challenge to us has been to assure that the entire organization has one as well, that it affects the way they perform, and that they convey it to our customers.

I knew that what we didn't want was some kind of a "public relations" program with no real substance behind it. All too often, this is what organizations believe a service orientation is all about.

I know of one service organization that came up with the slogan "pride in performance," which was printed on their departmental stationary and intoned by the director at staff meetings and briefings. So far as anyone could tell, that's all there was to the program. Another service organization painted the slogan "pride in service" on the side of all of their vehicles . But so far as anyone could see, nothing else changed in the way they did business.

What we did want was a program that got to the fundamentals of individual attitudes, the way our people deliver service, the policies and procedures that guide the performance of the organization, and the way that the various divisions of the organization worked together to deliver service.

There were two fundamental resources that were needed to successfully develop and carry out such a program.

First, we needed a professional training capability within our organization to manage such a effort. We were able to do this not quite two years ago when we established a professional personnel and training manager position and Marilyn Lockhart joined our organization. One of the first tasks that I gave her was to explore the feasibility of developing a service excellence program for the entire organization.

The second prerequisite for a successful program was the availability of a qualified and experienced professional in this particular kind of training that could develop the program for us, conduct key portions of it, and guide our own staff in conducting the program. We were fortunate that such a person was available to us through our University personnel and training organization. This was Beverly Wann, who had been conducting some generic programs for service organizations. Beverly developed a proposal for our Service Excellence program that has guided us throughout its development, with some periodic modifications as we learned more about our needs or began to see the results.

Beverly and Marilyn have worked together as a team in guiding our Service Excellence program and we will be hearing from them now about it. I will follow with some comments about the results we seem to be getting from the program and some thoughts on how we are trying to make it a permanent part of our departmental management program.

II. INITIATION OF A CUSTOMER RELATIONS PROGRAM (Beverly Wann)

I'm going to describe the initiation and development of the Service Excellence program by outlining the original program goals and the changes in scope and focus that occurred with each of the early phases of the program.

The proposal for a comprehensive department-wide customer relations training program that I submitted to Bill in February 1988, was based largely upon my experience delivering a workshop for the University of Virginia called, "Managing for Service Excellence." In it, managers from dining services, libraries, parking and transportation, and computer services, as well as from physical plant, applied the theory and techniques from the book Service America to the complex world of a large public

university. The authors of Service America contend that customer service in this country is very poor largely because the service aspect of most organizations and businesses is not consciously managed, and because customer contact employees are not trained in service. (Employees are often told to "smile", but that doesn't last long!) According to the authors, good service requires a strong commitment to customer satisfaction from the top management, a customer-oriented culture that permeates all levels of the organization, an on-going means to measure customer satisfaction, management that sees its role as serving those who serve, and front-line workers who are given the resources, training and permission to be responsive. They contend, and I wholeheartedly agree, that service depends upon empowering your people to serve. In other words, it depends upon helping your people so that they will help the customers.

The workshop "Managing for Service Excellence", offered each semester on an open enrollment basis to all University managers, is usually met with both enthusiasm and frustration. The managers are clear about the benefits of having satisfied clients, patrons and "violators" (the name Parking and Transportation gives to its customers!). But, they ask, how can we be responsive to customer desires and demands when we are dealing with a bureaucracy, with very limited funds, and with few concrete ways to reward our people? After trying to help these managers address these issues in isolation, I welcomed the chance to assist the Department of Physical Plant in developing and carrying out a program that would consist of more than sending a handful of people to a workshop.

The original Service Excellence program proposal outlined six phases that would include an assessment of current customer desires and expectations, the development of a department-wide strategy concerning service, training for the management of a customer oriented organization, training in customer relations skills for front line employees, and strategies for ensuring that the new level of service would be maintained. In addition to improving the quality of service, our intent was to increase each employee's appreciation and understanding of the department as a whole and of his or her contributions to it.

I will briefly describe the six phases as they were proposed.

Phase I called for the senior management group (Bill Middleton, the Deputy to the Assistant Vice President and the ten division directors) to meet in order to tailor the proposed management level and front line level training to the needs of the department. It was also to be a time for this group to make some of the decisions concerning such issues as the mix of participants in the workshops and ways to handle the suggestions for improving customer service that would be generated in the training. This phase was designed to solidify the senior management group's commitment to the program by inviting their

input at the ground level.

Phase II called for a series of group interviews to gather information about customer needs, desires and expectations. The groups would represent all levels of employees and a cross section of users.

Phase III was to be the development of a mission statement regarding service. Based upon customer needs, it was to provide a unifying direction for the program.

Phase IV was to be the eight-hour workshop for all management and supervisory level employees on how to manage a customer oriented department.

Phase V called for a training of trainers program to prepare in-house employees to deliver Phase VI, the front-line worker customer relations training.

That was our original map. It guided us in the right direction, but neglected to warn us of some of the rocky terrain along the way.

In reality, Phase I consisted of one full day off-site, and a half a day several weeks later, during which the senior management group struggled to decide what an extensive training program should be and would be. Management expressed concerns that the program would raise employee expectations to an unrealistically high degree and would surface frustrations that couldn't be remedied. Another concern that was brought out was that the program might skirt some of the core internal problems and therefore not produce true or lasting results.

During Phase I it was decided that all of the proposed workshops needed to address the issue of employees not understanding how the divisions fit together and function as one department. To help improve that situation it was also decided that the workshops would have as diverse a group of participants in them as possible. Finally, in Phase I, it was decided that Bill would meet in person with groups of managers and supervisors to introduce the Service Excellence program.

The program was presented to the managers and supervisors as a means to strengthen the departments' responsiveness to users. There was emphasis placed on the fact that all levels would be involved in identifying and making improvements.

The information gathering sessions, Phase II, followed. They consisted of two-hour meetings with a group each of managers, supervisors, front-line workers and outspoken customers. The meetings revealed a host of complaints and frustrations that are probably all too familiar to many of you. Essentially, the meetings indicated that the users were satisfied with the quality of work they received but were unhappy with what

they experienced to be a large confusing and often unresponsive system of service delivery. The cost of the work was also a major complaint.

In addition to answering questions about the customers, the employees used these meetings to describe significant barriers to their being able to please the users. These barriers included lack of coordination between the department's divisions, lack of clarity as to when to fulfill a customer's request for additional work not previously agreed upon , and lack of resources to meet the large workload.

It was clear from these meetings that the employees were going to need to see that management was committed to improvement in several of these areas before they would actively join in the effort. Serious concerns that this program would result in no real changes needed to be directly addressed before the training began.

It was at this point that Bill appointed three task forces to study some of these specific problem areas and make comprehensive recommendations. The task groups included representatives from all levels of the department.

It is worth noting that the final report on these Phase II meetings was sent out to all participants in an effort to demonstrate that problems and concerns could be openly discussed.

Phase III was to be the development of a Service Excellence strategy or mission statement. No consensus was reached, however, as to the exact outcomes hoped for from the program. The general goal decided upon was: to increase responsiveness to customers by 1) modifying service delivery procedures to meet customers needs, 2) improving internal coordination and 3) improving communications with customers.

Last summer, with the foundation for the program in place, I conducted the one-day workshops for six groups of managers and supervisors. This was Phase IV. The participants welcomed the chance to improve Physical Plant's reputation in the University community, to reduce the number of complaints they had to respond to and to have their workers feel less defensive when interacting with customers. They were clear though, that current procedures and conditions needed to be changed in order for these things to happen.

In the workshops, the managers and supervisors were asked to put themselves in their customers' shoes and describe a typical customer's experience with physical plant from the beginning to the end of a project or request. They discussed and planned strategies for improving service in the following four areas:

1) Making procedures, forms, policies, etc. more "customer friendly."

2) Keeping the customer and each other better informed throughout a project.

3) Negotiating work with requesters -- how to be responsive to requests while also setting limits and offering professional advice.

4) Supporting their workers (addressing their major stresses) so that they can be more responsive to requesters.

Two categories of strategies were identified. First, those changes they could make or have made, and second, changes that would require assistance from top management.

They also participated in an exercise that had them diagram how each of their jobs affected each of the other participants in the group. A good example of the kind of discoveries that were made during this exercise was a maintenance worker describing how a certain kind of floor tile bled when it was cleaned and an architect then confessing that he was the one who specified that kind of a tile!

The workshop evaluations indicated that the most helpful aspect of the training was the interaction between people from different parts of the department; getting a better picture of how they related to one another and realizing that they had common concerns.

All of these things were accomplished though, only after the participants had been given the chance to air their concerns and frustrations. They were unanimous in their desire to communicate directly with Bill and the directors about internal issues. They wanted proof that their ideas would be considered seriously and that they would not be reprimanded for speaking out. They wanted recognition from the senior management group but especially from Bill for work well done. They and their people felt that they only heard from Bill when something went wrong. They were suspicious about the motivations behind the program and skeptical of its outcomes.

After three of these workshops were completed, we had learned that training alone, and even training with three task forces in place, was not enough to respond to the loud request for participation, trust and recognition that was coming from the managers and supervisors. Before continuing on with the next three workshops, Bill announced that he would meet personally with each of the six workshop groups to listen to their suggestions and concerns. This allowed the remaining workshops to be more positive and productive.

At the end of the six management and supervisory level workshops and at the end of the six group meetings with Bill, we

had accumulated a very lengthy list of problem areas and ideas for improvements . The task of responding to them and acting upon them seemed overwhelming.

Up to this point, the three of us presenting this paper, Marilyn, Bill and myself, had heard first hand from over one hundred employees their perceptions of what was and what was not working well in the department and what was needed in order to improve service. The other members of the senior management team had received all of this information only through reading the summary reports. Perhaps this was a mistake. The employees definitely wanted to see and talk with Bill himself but the task of sorting through and incorporating the wealth of ideas had to be taken on by the whole senior management group. Towards this end the directors, Bill and myself took another full day off-site to strategize. The day was spent primarily in a role clarification and team building effort for the group of twelve. How did they view each other's role in the department? What did they expect of each other? What did they need from each other, and especially from Bill? The Service Excellence program was pointing out problems that stemmed from weaknesses in terms of their functioning as a team. The directors requested from Bill more participation in decision making. The group also discussed the need to focus more on solving problems and less on blaming someone or some division for the problems.

It took several more meetings for the directors to prioritize the vast list of suggestions and problem areas. Using a nominal group process, which is more inclusive then taking a vote, but less time consuming then pure discussion, a final list of thirteen priorities was arrived at. These items were then translated into objectives. Marilyn will speak about some of the real outcomes of this process after I am finished.

The early phases of the program looked to many like the "opening of a can of worms". Poor customer relations were labeled as the "symptoms" of internal management, communication and coordination problems. The program took on the challenge of improving internal relations along with customer relations and has stimulated many positive and significant changes in both areas. (It is important to remember though, that real changes occur slowly and that evidence of progress must be frequently communicated to the work force, in order to ensure their continued investment.)

The scope of this program broadened in its early phases but the tenets we started with did not change. Customers <u>are</u> best served when the employees feel supported by management.

III. <u>Responding to Employee Suggestions/Empowering the Work Force</u> (Marilyn Lockhart)

My job as personnel and training manager at physical plant has been very challenging, exciting and fun as the Service

Excellence program has been designed and implemented. I have also had a few worrisome moments when I wasn't sure how everything was going to work out.

I have been an integral part of the program from the beginning. When Bill told me he wanted a Service Excellence program, I researched who was an expert in the subject and could guide us through the process. I was delighted to find Beverly. We have worked closely together through the program; I have attended every information gathering session, workshop, and meeting.

My concern throughout the program has been whether or not there would be any substantial changes. I'm sure you and your employees have attended good training sessions, but later have seen little, if any, changes in behavior. I am pleased to say that we have had some changes and I expect more in the future.

In the information gathering sessions and the manager/supervisor workshops, as Beverly mentioned earlier, we heard employees say they had lots of ideas on how to improve procedures to deliver better service. Some of the ideas and suggestions were simple enough to implement immediately. These included changes like: informing other department employees who will be working on a project by presenting an overview and tentative schedule for each project; increasing personal contact with customers; providing feedback to architectural and engineering services staff on design factors that effect maintenance; and posting a sign that says "work being performed by physical plant" on all renovation projects.

Numerous task force groups were formed to study more complex topics and make recommendations. Customers were included in the groups to assure their representation. Employees from varying divisions and levels were included. In addition to studying a problem or situation, the groups served as a way for people to get to know one another and to build a feeling of cooperation and teamwork.

One group investigated and recommended the establishment of customer service representatives. The purpose of a CSR will be to improve communications and coordination between physical plant and customers. The customer service representative will be an employee of our department and serve as the primary contact for assigned customers. They will inform customers of physical plant activities, status of requests, planned work, and preventive maintenance activities. The representatives will educate customers on physical plant policies and procedures. They will coordinate and schedule planned service shut-downs. Another very important duty will be to learn the customer's business and facility. Hopefully, customer service representatives will open up the physical plant "black box" which Bev and I heard us referred to over and over by customers. As soon as personnel forms and actions are completed, these people will be hired.

A second task force developed recommendations to improve service responsiveness. These recommendations included new and revised procedures to permit individual physical plant employees to use the greatest possible level of initiative and judgment toward providing prompt and effective response to service needs identified in the field.

A third group was formed to evaluate the distribution system of all written information, including U.S. Mail and department correspondence. We are currently awaiting their recommendations.

A fourth group has been studying material procurement. This group is looking at storeroom stocks and procedures, material standardization, processing of procurement forms and long lead material items. A fifth group is examining workload planning and scheduling. Other groups have studied automation and standardization of time clocks, and a possible van service to transport employees to and from job sites more efficiently.

Another group studying internal and external communications of the department, has opened new channels of communication and exiting channels have been strengthened. The current facilities coordinator system was studied in depth. Each school, department or building at the University has one or more facilities coordinators appointed by the dean or department head. These people request services, approve and forward written requests, coordinate the provision of services with physical plant and act as physical plants contacts when utilities services must be interrupted. The facilities coordinators are the main customer contact person for physical plant. Upon examination, the group found that no real description of duties had ever been written. The facilities coordinator concept was a good idea, but had never been fully utilized or defined. The task force mailed 400 questionnaires to all facilities coordinators, deans and department heads to assess their understanding of job duties and payment responsibilities. The questionnaire results showed only a fair understanding. A second questionnaire was sent to test specific ideas for improved communication. The task force believed feedback from customers on specific ideas was necessary before decisions could be made on implementation. As a result, a comprehensive job description for facilities coordinators has been written and distributed. A short summary of service payment responsibilities has been designed and distributed. Personal contact with facilities coordinators has been increased to educate them on physical plant procedures.

Implementation of recommendations for internal communications have begun opening new channels of communications in the department. Many employees expressed a strong desire to communicate directly with the department head.

Based on a task force recommendation, Bill Middleton has been meeting with small groups of employees to talk about the

department's direction and activities; and employees' concerns and suggestions. These have been successful and have given people a better understanding of the department. They have also alerted Bill to some employee concerns. A 24-hour telephone answering service was installed so employees could leave messages for Bill Middleton about any department/job related concern affecting job performance. Another recommendation being implemented is a department-specific employee handbook. The handbook will update employees on the goals, objectives and procedures of the department. The handbook will be given to all new employees during their physical plant orientation. Veteran employees will be given the handbook during "reorientation sessions." These sessions will be conducted for all employees to educate them on division responsibilities, to foster a feeling of teamwork and to explain how the department is changing and what its role is in the University's "big picture." Bill Middleton, division directors and I will meet with 50-60 employees at a time to conduct these two-hour long sessions beginning this fall.

Other new changes and channels of communication include:

1. Service Excellence Bulletins published monthly. The bulletins serve as progress reports to let people know what's happening with the program.

2. A task force group is currently studying ways to improve the project tracking system. Many complaints were made about the department project reports being outdated. These reports are a vital link with our customers.

3. The building trades superintendent has started sending customers a survey when each job is completed. The survey tells the supervisor if customers needs have been met. The survey communicates to the customer that physical plant cares about what they think. Some of the things customers have said are:

    - "A beautiful piece of work, I've always received excellent service and great workmanship from the furniture shop."

    - "The staff at physical plant is always very efficient and most cooperative. It's a pleasure to 'to do business' with them."

    - "Just keep lines of communications open to the customer, especially approximate time when the work will be completed."

    - "Your service was fine, the hold-up was the administrative channels it had to go through to finally get to you."

Overall, the surveys have shown that customers are pleased with the work once it's completed. It's the paperwork and communications that cause problems. We're hoping to improve the communications part.

4. Our Architectural and Engineering division has begun to hold pre-construction meetings while will involve all concerned physical plant people.

5. At the end of projects, wrap up sessions are now being conducted to assess what worked and what didn't work during the project. We want to learn from our successes and our mistakes.

6. We heard many times that the form the secretary fills out for trouble calls was not "user friendly" to the person in the field. A group has been formed to improve this form.

7. All managers and supervisors have made commitments to see more of their people. Our employees have said over and over they want personal contact and we are trying to help in this area.

Frontline workers training began in April. The training is designed to give employees an opportunity to assess the quality of service they provide, and to plan strategies for improving that service. It is also designed to enhance communications and teamwork in the department.

During the training, participants discuss reasons for improving the quality and responsiveness of physical plant services; list reasons why their interactions with customers are crucial to the reputation and operation of the department; discuss and practice effective ways of handling confused, dissatisfied and/or angry users; and identify strategies for communicating the professionalism of physical plant employees to the customers.

All 600 employees of the department will attend these day long sessions. Beverly Wann trained six teams of physical plant managers and supervisors to conduct the sessions. We believe that people who are managers in the department will be able to best answer real life work concerns, and therefore will be the most effective trainers. Beverly and I conducted the first two sessions, but have now turned them over to our in-house trainers. They have been fun, exciting, and difficult so far. On the training evaluations, people have said they enjoyed most the opportunity to get to know people from other areas of the department. It will probably take about a year to train all of our employees.

Another need expressed over and over by employees was wanting increased recognition of quality work. We all know that we hear plenty when something goes wrong and very little when something goes right. There has been an increased emphasis in the department to remember to say "thanks for doing a good job." All of our directors, managers, and supervisors are trying to do better. When a complementary letter comes from one of our customers to Bill Middleton, he now writes the employee directly, instead of to the supervisor. We are all trying harder.

IV. KEEPING THE INVOLVEMENT AND INVESTMENT ALIVE
(William D. Middleton)

I will close our presentation with a very preliminary assessment of what I think we may have accomplished, together with some thoughts about what I hope to accomplish over time and how I hope that we can make Service Excellence a continuing, integral part of our physical plant program.

What have we actually accomplished?

As some of the examples that Beverly and Marilyn have cited indicate, I think our organization is becoming much more conscious of the importance of a service orientation, and the need to demonstrate it to our customers within the university community. Perhaps the important thing here is that our organization is becoming much more aware than it was before that just doing a good job isn't always enough; we need to take positive steps to let the customer know what we have done or what we are doing, and to be sure that they are satisfied with the results.

Perhaps equally important has been the level of "participatory management" that we have achieved through the structured Service Excellence process of the past year, and the value that this has had for our organization.

Much like any other physical plant department, we have a fairly rigid, structured organization and management hierarchy; most of you would probably agree that we need this to get the job done effectively.

Within this structure we encourage communication up and down, we have a suggestion system, and we use an employee council as a means of staying in touch with the needs and concerns of our work force. And I think that this all works reasonably well.

Still, I was surprised -- and pleasantly so -- at what we learned through the series of Service Excellence meetings with our people at all levels of the organization, and our customers:

- o almost uniformly, they were truly concerned and serious about wanting to do the best job possible.

- o they had a lot to say about the organizational practices and relationships that they felt were hampering their ability to do the best possible job.

- o and, they had a great many good, sound ideas about what we could do about it.

We have been able to tap all of this energy to make the changes we need to enhance our service capability. Marilyn mentioned, for example, a number of the task forces we have established to explore specific problem areas in depth and to recommend solutions. In this process we have used, to good effect, a great many of these bright, articulate and thoughtful people from throughout our organization. Certainly, members of our organization are now involved in the management improvement process in a far broader and more effective way than ever before.

What we will do to keep Service Excellence alive and well as an active, continuing program after the initial phases are over has been one of my greatest concerns. In order for Service Excellence to have lasting value, we must find effective ways to do this.

At this point, we certainly don't have all the answers. But here are some of the things we are planning:

- o a Service Excellence training program for all new employees.

- o Service Excellence refresher training on a periodic basis for all of our staff.

- o continuation of Service Excellence's "participatory management" through the establishment of some kind of a Service Excellence committee that will represent a broad base of physical plant management and supervision, our work force, and our customers. Their task will be to continually appraise how we are doing, and to suggest new or change practices that will help us to continually strengthen our commitment to quality service.

Certainly, Service Excellence has been an exciting venture into "participatory management" for us; at times the energy, the enthusiasm, the expectations that we have brought forth have made us feel that we had the proverbial "tiger by the tail". But based upon the results we've begun to see, and what I hope are realistic expectations of what it will achieve for us, it's been a worthwhile effort.

Teamwork: Leadership Not Pushership

Polly Pinney
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Good Morning! It's a pleasure to see your smiling faces. Makes me wonder what you've all been up to this week. In my preparations for this presentation I found a very interesting set of statistics I'd like to share with you. During the remainder of this hour, 25 per cent of you will follow my every word with rapt attention, another 25 per cent of you will drift in and out and absorb some of what I have to offer, and the final 50 per cent will nod off and have some sort of fantasies. I was delighted when I read that! It means at least 50 per cent of you are going to enjoy yourselves today.

Our subject for this session is Team Building: Leadership <u>not</u> Pushership. For the next hour, I'm going to share with you techniques that help to develop a strong team concept and team leaders. In doing this, we will be discussing the illness, the symptoms, the suggested cures, and the long term prognosis for a virus I shall refer to as the Staff of Strangers. I will not present team building from the traditional perspective of a list of techniques but rather as a total concept. I'm not going to give you anything particularly new or earth shattering, but what I am going to share is how Arizona State University Physical Plant took a number of techniques and molded them into a program that works.

The ASU Physical Plant is an organization of over 600 people dedicated to the smooth operation of a 105 building campus located on 640 acres serving the needs of some 44,000 students and 6000 faculty and staff. When I joined ASU Physical Plant five years ago I encountered an organization functioning in spite of itself. From a staff relations perspective, the gulf between the back door to the dock area and the front administrative offices might as well have been a moat repleat with alligators. A prevalent

Attila-the-Hun management style, lack of communication, and frequent administrative turnover had united to produce the 5 D's.

distrust

disillusionment

demoralization

dislike

disloyalty

A long line of lawsuits, grievances and employee complaints arrived at my door daily and to say the least, I began to feel a bit like the Cruise Director for the Titanic.

I used my morning walks up the dock as a barometer of the department. What I saw was bowed shoulders, scowls, heads down, refusal to acknowledge a simple good morning and general resentment of the administrative management structure. If I had been a physician, I would have marked my diagnosis, morale problem, prognosis guarded, and gone on to another patient.

Instead, since management by wandering around was in vogue, I wandered around and I listened. Listened to the staff - listened to the managers - listened to the front line supervisors and to the administrators in other departments on campus - listened to the grievance committee members - listened to the ombudspersons who had been involved with employee complaints. In short, I listened to anyone who I felt had some reason to possess knowledge on the subject including the President of the local non-recognized union. The dilemma appeared to fall into two categories in need of solutions.

- organizational remedies, and
- style remedies for the management team

From an organizational perspective, there was no formal network for vertical, horizontal, or lateral communication. Employees complained of experiencing their work life "after the issue," rather than knowing ground rules and expectations up front. There were complaints of policy changes that were never announced to the staff, of directives given with no explanation or reasoning, of generic reprimands, of unfair promotions, of a general lack of information. Labor/management relations in some areas of the department experiencing heavy turnover, resembled a strip mining operation with management exploiting the staff then moving on to other staff regardless of the damage done.

What sounded like a complicated maze of problems was condensed to one overall issue - lack of communication - resulting in 600 people with no sense of overall purpose or belonging.

Our proposed solution included three communications components. The first component was the establishment of strong human resource policies and programs geared to bring the plant together as an entity and impact the organizational style. This resulted in a beefed up safety operation, an expanded training and development program, a Key Employee of the Month/Year Program, a series of staff recognition programs, an Attendance Incentive Program, a newsletter, a new internal policy and procedures manual, and a campus public relations effort to enhance the image of the Physical Plant and its staff.

The second component was to establish employee advisory committees to give input to the Directors office on issues of general concern to the staff. This would seem to be a simple, straight forward process, however, ground rules needed to be established for what the committees would or would not deal with. Due to the 5 D's, staff at first tended to view the committees as "bitch boards" and forums to address personal grievances, rather than sounding boards for issue management. We instructed the committees to establish charters of operations with goals and objectives clearly spelled out. After much deliberation, the groups agreed on the following overall goals.

- The committee will act as liaison for Physical Plant personnel on matters of policy as defined in the Staff Personnel Manual, Physical Plant Policies and Procedures manual, and other matters as elicited by the Director of Physical Plant or designee.

- The committee will serve as a resource to address issues, assist staff in understanding existing channels of communication and encourage them to use such channels.

- The committee will review and recommend revisions of related Physical Plant policies and procedures, and performance and merit evaluation systems.

The third component was to institute regular meetings of the shop personnel. During these meetings, supervisors were to discuss current issues, relay information, announce promotional opportunities, and give safety information. The advisory board members were also to have time on the agenda, as were the shop safety representatives.

This was the groundwork for our even larger task of amending the management style, building a team atmosphere for the department, and impacting the infamous morale problem. The existing management style was both uncommunicative and aloof. It was perceived as uncaring and cold, unethical and unresponsive.

To motivate people we must satisfy their most important needs. One popular management study defines the first five needs as:

- being appreciated

- being kept fully informed

- being listened to
- consistency
- firm and fair discipline

Do you recall the list of staff complaints?

- experiencing work life "after the issue"
- policy changes that were never announced
- directives with no reasoning
- generic reprimands
- general lack of information

But, you had already addressed the communications problems, you say? Yes, we had, from an organizational perspective. We had not, however, even begun to address the staff perception of this group of people who were prodding them to greatness.

James L. Hayes in Memos for Management defines ethics as:

"To see ourselves as others see us"

Our problem now became:

- altering the view of ourselves others were receiving, and
- altering our view of what was effective style

We embarked on an extensive team building effort that included three components:

- management by example
- coaching
- training and development

Utilizing management by example, we opened communication by holding more frequent meetings with supervisors and requesting more input. In addition, we published the formal goals and objectives for the department in the department newsletter, as a step toward sharing the vision of where we wished to go as a team. We endeavored to "get out of the office" and become visible and accessible. And in addition, we created a semi-annual management retreat to relax and recharge with one another, and help to develop camaraderie.

Don Robinson, Coach for the ASU Gymnastics team, is a ball of enthusiasm and energy waiting to happen. And in Don's case, he happens with great regularity to anyone, or any group, he is with. His teams have received international acclaim, and he is a nationally recognized motivational speaker. We adopted Don's formula for successful teamwork, and we stressed its use by all department supervisors.

R + C + S + G

R for recognition - everyone needs to feel recognized for the good they do but we often recognize only the mistakes

C for communication - the key to all your life's experiences is an ability to listen and hear

S for service - because that is our only product and we should always offer a little extra

G for gratitude- the missing link in most communication.

And last, but certainly not least, we placed our money where our mouth was and created the annual Physical Plant Supervisory Institute, dedicated to enhancing the skills level and style of our present management/supervisory team.

From its inception, PPSI was a novel thought. Never before had plant management so openly and obviously backed the concept of sound human resource management. We surveyed management, staff, and supervisors about what skill areas they most desired training in and what areas they felt the most critical need for training. We then formed a year-long program, based on those topic areas, taught by the very best talent we could find. The eligible group applied for class membership, and in addition 13 non-supervisory staff were chosen by lottery from applications of interest.

We promoted the program actively and left no stone unturned in researching ways to make it special and memorable. We mixed the sections so all areas of the department were represented in each morning and afternoon sessions.

The results from this endeavor exceeded all our expectations. The supervisors were delighted to have something special - just for them, and the staff were delighted we cared enough about the quality of their supervision to try to improve it. Almost immediately we sensed a common interest in the program from all areas of the department. In the sessions, the dynamics were startling.

What developed over the months was a sense of togetherness, built from understanding of each other's operations, and the ability to relate to each other as humans. Between session one and session ten, the atmosphere changed from sedate and careful, to flamboyant and open enough to develop "in" jokes and dive into one another's problems with ease.

The following list of Maxims to Break and Maxims to Live By sum up the change in philosophy currently infecting our department.

Maxims to Break	Maxims to Live By
If they don't see you, they can't hate you.	People will rise or fall to the level of expectations.
Joy is inappropriate in the work-place.	To know you may not be to love you - but will certainly develop understanding.
If it's fun, it can't be work.	Laughter produces a sore stomach - and togetherness.
The less they know, the better.	Crow has a better flavor when eaten voluntarily.
If they're not for me, then they're against me.	Get rid of your enemies - let them understand you.
Supervisors are always right	

I still use my barometer. As a matter of fact, it's a high point of my day. The day before I left for this conference I took my standard walk up the dock in the morning (as well as a walk or two I have now built into my day.) What I now see and hear is in marked contrast to my earlier description. I see people who are busy and bustling, each moving with purpose and energy. I see smiles and I hear laughter. It usually takes me ten minutes to travel the yards from the service yard entrance to the office door, and during that time, I catch up on people's lives and issues. We share now, and there is a sense of a team. The PPSI class has graduated, and talk has turned to next year's sessions. Our supervisors, now attached to the retreat concept, have just hosted the first tri-university supervisors meeting. The advisory committees are responsible for the inception of two of our most successful department program efforts, and I have quit referring to the now defunct line outside my door as job security. The divisions of the department are no more, and what stands in their place is one unit that has learned a collective problem solving process.

Harvey Mackey, in his book Swim with the Sharks, maintains that there are only two times in your life when you are truly alone, when you die and when you are making a speech. Your interest and attention have eliminated one of those instances. I thank you for sharing this hour with me.

Training: A Continuing Process

Thomas F. Vacha
Director, Plant Operations
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Introduction:

I think if I were to ask for a show of hands as to how many of you feel that training for all levels of your organization is important, I would get a unanimous response. On the other hand, if I were to ask how many of you actually run training programs for all levels of your organization on a continuous basis, I suspect I would see a few less hands in the air. Problems related to tools, stock, heating, cooling, etc. are most likely to get your immediate attention. They tend to get resolved quickly. The results are usually obvious and quantifiable, or at least your telephone stops ringing. Training on the other hand, is a little more subtle and less likely to demand your attention on a daily basis. So who gets the grease? The squeaky wheel of course. That shouldn't be so in a Physical Plant Department, should it?

Although it is a little like giving a history lesson now that I am no longer at MIT, I would like to share with you some thoughts about what I did there in the way of training.

Questions

Let's take a few minutes to ask ourselves a few questions about the subject. Why conduct training? Your answers should include such responses as new employees, turnover, promotion, transfers, new buildings, renovations, new equipment, new procedures, revised codes etc. Even these probably only represent the tip of the iceberg. Next, let me ask, who needs

training? I would hope that your answer would be that everybody needs training in one form or another. That includes your shop, grounds and custodial personnel, your clerical support personnel, as well as the members of your management staff. How many types of training come to mind? You no doubt will think of classroom, self study and on-the-job training. Any others? What resources might you have available to you to conduct training? Consultants, vendors, packages, and some of your own people top my list. How do you know what type of training to conduct? Isn't any kind of training good? The fact of the matter is that you do not want to waste time and money training people on issues that they either won't use or worse that they already know. If they know that they will never use it, people can't help wondering if you really know what you are doing. If they already know it, they can quickly get bored and even disruptive in the classroom environment. So what do we do? You got it, we develop needs. And just how do we do that? We must determine where we want to wind up. Who sets out on a trip without a destination, without a map? The differences between where we are and where we want to end up are our needs. The needs can be cost estimated. They can also be prioritized.

Hourly Staff Training

Let's start with the hourly trades. What do you think I found? Next to nothing. A room with a table and a few chairs along with a collection of manuals arranged in no particular order. What do you think I did next? I got a new training supervisor, one who understood that we could really accomplish something if we approached the task in an organized fashion. Then I got the trades supervisors to develop an outline of the skills that they felt were required for each particular trade. After a series of revisions, they all signed off on the document. It became theirs, not mine. Next came the task of getting the supervisors to rate their employees. What do you think happened? Just as you might suspect, the values were all over the place. I developed a merged list of the ratings and presented it to the manager and his supervisors. It sure got the ball rolling. We did have to go back and clarify some of the definitions. It took several tries, with the individual employee rating sheets actually laid out in front of the supervisors. Eventually we got the measurement issues resolved and we all finally agreed on the evaluation criteria. Each supervisor keeps the rating sheet for the employees that report to him and he is responsible for keeping the sheet current. If he thinks something should be added or taken away, he updates the sheet immediately. Twice a year the sheets are picked up and the merged list meeting is conducted. The Training Supervisor lists the needs, works with the supervisors to estimate the costs, suggest methods of accomplishing the tasks, then he turns the package over to the manager. The manager establishes the priorities and the Training Supervisor arranges for the training to take place.

Spin-offs

What were the spin-offs? The data assists the manager in developing rotation plans. Some on the job training is accomplished simply by rotating the employee to a different work group for a period of time. The analysis helped to review staff reduction impact. We used the data to develop areas of staff weakness and would target our new employee selection to fill those

gaps. The supervisors use the same format during the interview process. So even a new employee has an evaluation sheet developed as part of the interview process all subject to change of course as that new employee gets introduced to the operation. People are given credit for tasks that they can explain. It is the job of the particular supervisor to verify performance evaluations as he/she becomes aware of deficiencies.

Supervisor Training

What about supervisors? My analysis indicated that we needed across the board training in leadership techniques, in administration, in letter writing, in presentation techniques, as well as in Labor Relations issues such as coaching, counseling, handling discipline and grievances, etc. I had twenty (20) first-line supervisory level individuals in my organization, most of whom at least finished high school. They were all the best in their trade, but that wasn't really their job any more. Sure they needed the technical knowledge but they didn't work with their hands any more. We now expected them to speak, write, reason, analyze, etc. All skills for which they were never really trained. Most of these individuals had filled in from time to time as supervisors during vacations, illnesses, etc. so we knew they could coordinate work. I don't think much thought was given to anything else. I felt that they were the least trained of all of my employees.

An editorial in the Boston Globe a while ago written by a couple of Human Resource Professors at Northeastern suggests the idea that ineffective first-line supervision is the key cause of high turnover and low productivity. Their interviews indicate that employers consider supervisory development programs a "luxury". There premise is that a human resource program that concentrates solely on hiring and ignores training and development is self defeating and futile.

I came across the TPC Training Systems Course entitled "Maintenance Management for First-Line Supervisors" and I decided to give it a try. This package contained ten blocks or volumes consisting of five lessons each. It is intended to be a self study program. I did each lesson myself and from that base, I developed an "MIT oriented" lesson plan that I utilized to present the material to my twenty supervisors. We taped each session and had handouts so if somebody missed a class because of vacation, etc., they could easily catch up. Each session lasted approximately one hour. Each of the ten blocks was preceded with a fifty (50) question quiz. I generally took more than the five hours allotted for each session because I would supplement the program with guest speakers and films on the topics. At the end of a block, I would give the fifty (50) questions quiz over again and see what kind of progress was made. I didn't just give out the correct answer. I would spend at least a couple of sessions reviewing the questions that people got wrong and talking about the reasons that they might have had for selecting the incorrect answer.

I made an agreement that the results were to be between the individuals and myself. No intermediate supervisors were informed of the grades. I gave everybody back their grades along with the average so they could see where they fit into the profile. The second phase of that program for

employees who either missed parts of the first program or are new Supervisors, is currently underway. It is being taught this time around by some of the managers and staff personnel providing them with the opportunity of getting up before a group and speaking in a training environment.

Spin-offs

I told the supervisors that it was a unique opportunity for me to pass on directly to them unfiltered by the chain of command, my philosophy and values on the subject of plant operation and management.

Other issues

We established a continuing series of Training Bulletins. Every time a new system was introduced, the Training Supervisor would get the instructions written up, published, distributed to the employees, and posted in the work place.

We purchased a video camera and two players. We used the players for packages we rented or packages we made ourselves. The CUP had a lot of tasks that they only did once in a while. If a person wanted to refresh themselves on a process they could pull the film and watch it prior to going on the job.

Summary

I guess you can see that I am a training enthusiast. I believe in it and I know full well that I need to be the prime mover. With all of the other issues that were underway I truly felt that if I backed off the program would suffer. We can all get caught up in the pressures of the minute, especially those of us without the luxury of having a person whose sole function it is to work on training. You simply can't let that happen any more than you can let up on safety, quality, etc. When it comes to training you can't afford to be a Sunday Catholic. You must believe in it and keep after it all the time. The challenge is to get people to consider training and staff development essential for organizational survival and not just a luxury to be abandoned at the first sign of economic difficulty.

Presupervisory Training: Less Talk, More Action

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Training & Communications Coordinator
Indiana University, Bloomington

This presentation will describe the development and implementation of the presupervisory training program in the Department of Physical Plant at Indiana University Bloomington.

The IU Bloomington (IUB) campus is located in a predominantly rural county in the rolling hills of the southern third of the state. The campus serves about 33,000 students. There are 450 buildings (about 14,000,000 square feet) on about 2,400 acres.

The Department of Physical Plant has over 700 fulltime employees and many seasonal and part-time employees. The department's major operational divisions are Campus (grounds), Maintenance and Operations, and Utilities and Engineering.

Rationale for the Presupervisory Training Program

The department established the Presupervisory Training Program (PTP) to meet our need for well-trained first-line supervisors in our three line divisions.

Over the years, we have observed that when there is a major operational problem in a work area, the underlying problem is usually with supervision. Work areas that have struggled under a certain person have functioned more effectively after a change in supervision has been made.

Another factor that contributed to our decision to establish the program is our anticipated turnover in supervisory positions in the next few years. In the craft shops alone, we may have as many as half of our twenty current supervisors retire within five years. This is a special concern because a large percentage of our craftworkers are in

their twenties and thirties. They have had few chances for leadership or supervisory experience. Yet they form the most likely pool of applicants for future supervisory jobs.

In past years we have sometimes tried to acquire qualified supervisors by going outside the department. For example, we hired a refrigeration supervisor, but he stayed only about one year. He left for a construction job that paid twice as much as our supervisory position.

We have also offered our craftworkers a chance to try being supervisors. In one instance, after a few months as supervisors three craftworkers decided to return to their former jobs, rather than continue as supervisors. Their departure created delays and confusion in the shops. Two of the individuals also seemed to have developed negative attitudes toward anyone in management.

In the past, when we have promoted craftworkers to first-line supervisors, over time we provided them with a haphazard mix of technical and supervisory training from a variety of sources: the IU School of Business "Management Development Program", selected short courses (a few hours or perhaps a full day) from the university's Personnel Department, and off-site courses at a traveling consultant's seminar or at a service supplier or vendor's facility.

As if it was not bad enough to train people in supervisory skills only after we promoted them, the training we did provide was generic. We could not tailor the training to meet the specific needs of either the individual or the department. Not incidentally, the cost of some of that generic training (in particular, that offered by the School of Business) was fairly high.

Perhaps most importantly, after the training there was no way to know what new skills our newly-trained supervisors were now able to use on the job. Most of the training sources mentioned above do not test or otherwise evaluate trainees to certify what they learn either during or by the end of the training.

So the main goal of our department was to develop a pool of potential first-line supervisors who had some identifiable supervisory skills.

The department's second reason for developing the PTP was to offer a more formal and controlled opportunity for employees to advance their careers. By offering the program, the department was saying to its employees, "If you are interested in career advancement, we will help you prepare yourself for jobs that may become available within Physical Plant."

The program is not a guarantee of a supervisory job. But employees who are enrolled or who have completed the PTP are in a favored status when competing with other employees and non-department applicants.

Selection of Trainees

Once the Director of the department decided to develop the program, line management was heavily involved in the selection of the first group of trainees.

The department, through its Training and Communications Office, advertised the program in the divisions that were eligible to apply. We used flyers and posters, as well as word of mouth. Management held a special meeting for interested employees where it presented an overview of the program and answered questions from attendees. In hindsight, it would have been advisable to hold meetings with the individual shops to be sure that all employees understood the program and its purposes. Several employees wanted to apply after the closing date had passed - they had learned of the program's existence too late.

A selection committee composed of the managers of the three divisions set up the application criteria. They also prepared a set of interview questions to ask each applicant, and devised a rating scheme they would use in the interviews.

At the interviews, the managers rated each applicant's answers to the questions. Rating sheets also contained information on certain background variables such as attendance, use of personal leave, and disciplinary problems during the previous year.

After all the interviews, the Training and Communications Coordinator tabulated all ratings and ranked the applicants. The selection committee had intended to enroll eight trainees in this first class. That number would have permitted an optimal in-class interaction; however, there was a tie for the eighth spot. So the Committee decided to accept nine trainees: three from Campus Division, five from the craft shops of Maintenance and Operations, and one from the power plant in the Utilities and Engineering Division.

Program Structure

Class schedule. The PTP classes are held once each week (Thursday). Class starts at three o'clock and lasts from two to three hours, depending on the topic. Although the regular day shift lasts until four p.m., management decided that trainees could attend the first hour of classes on the clock. The rest of the class time is the individual's. We made one exception to this arrangement for a trainee who normally works the four p.m. shift at the power plant. This trainee attends class for only one hour on his time and two hours on department time.

Instructional approach. We planned the program to be a comprehensive overview of the knowledge and skills needed for a first-line supervisor at the department. It combines a lecture format with in-class participation of all trainees in practicing the skills for job performance.

In addition to the in-class practice, we give trainees a period of time on the job to act as supervisors in their work areas. For example, one of our Heat Shop supervisors retired in December, leaving a gap in our supervisory coverage. That was a perfect opportunity to have the trainees take over as supervisors. We scheduled each Heat Shop trainee for about four weeks as acting supervisor. During their time, the trainees had the same responsibilities and authority as regular supervisors. At the end of their tours the manager of the Maintenance and Operations Division evaluated the trainees.

In this particular example, we realized that four weeks might not be enough time for the trainees to get familiar with their jobs or to use the skills and knowledge from their classes. So we scheduled the two trainees who continued to express an interest in being supervisors for an additional eight weeks.

An important aspect of the training is the evaluation of trainees' progress. Each class has some type of evaluation that assesses the trainees' grasp of the skills and knowledge for that lesson. Sometimes the evaluation tool is a quiz or test. Sometimes it is a practical exercise in the form of a role play. Sometimes it is both.

Many of the lessons require homework. This comes in the form of a reading assignment or the preparation of a role play, sometimes in a pair or small group. Trainees must prepare on their own time. The instructor grades the homework, then returns it to the trainees at the next class or in campus mail.

In addition to the instructor, representatives of first-line, middle and upper management rate the role plays and in-class exercises. The trainees also observe and critique one another. The purpose of the ratings is to provide constructive feedback to the trainees so they can improve their performance.

Overall, the purpose of the classes is not to weed out but to develop the necessary skills. We have set a "passing grade" of seventy percent on all evaluations in order to get credit for a topic; however, we have had very few instances where a trainee does not reach at least that seventy percent standard. The trainees understand that if they do not attain seventy percent they will not have that topic of instruction listed on their completion certificates.

Curriculum

Selection of training topics. The Training and Communications Coordinator drew up the initial list of topics. Upper and middle management reviewed the list. We then submitted the revised list to first-line supervisors for their review and revision. Once we established the final list, the Coordinator grouped and sequenced the topics (Figure 1).

We grouped the twenty nine topics into five categories: general information (six topics), communication skills (seven topics), interpersonal relations (four topics), organizing skills (five topics), and shaping job behaviors (seven topics).

Instructional design. For each topic, the Coordinator selected an instructor or acted as instructor himself. The Coordinator prepared a packet of materials that instructors could use to design their lessons around a standard format (Figure 2). The standard format consists of the following parts:

1. Instructional Objectives. For each lesson, instructors write behavioral objectives for the trainees to achieve. Usually there are no more than two or three objectives per lesson. The objectives allow the instructors to focus their content and methods on only the information and in-class activities which will help the trainees achieve the objectives. Instructors delete "nice-to-know" information as much as possible, so the lessons are lean.
2. Instructional Materials. Here the instructor lists any reference material, handouts, audiovisual materials (film, videos, slides, overhead transparencies, etc.) or other print or media software.
3. Equipment and Supplies. The instructor lists any hardware, media equipment, tools or other "props".
4. Procedures. This section orchestrates the flow of activity between the instructor and the trainees. It sequences what is going to happen in class and who is going to do it. It also contains the instructor's approximation of the amount of time needed for each step in the process. This estimate allows the instructor to keep the class within the maximum allowable time of three hours.
5. Evaluation. Here the instructor enters the format to assess the trainees' accomplishment of the instructional objectives for the lesson. The most common methods are practical exercises and tests, although we do use other methods occasionally. For example, we had each trainee prepare a self-improvement plan for listening skills that outlined self-perceived areas of deficiency and specific methods of improvement, along with the benefits to various parties with whom the trainee comes in contact.

In addition to the lesson plan outlined above, the instructor prepares a content outline. This contains the main points of information that the instructor wants to convey to the trainees during the class. Sometimes this outline is rather short, especially for lessons that rely heavily on in-class activity by the trainees. For other lessons (for example, the General Information lessons), the outline is lengthy. The key is to be sure that the instructor does not depend on memory to present all the necessary information - especially if a test or practical exercise calls on that information.

The other main piece of the lessons is the quiz or test or practical exercise, and an answer key. Many lessons require some type of rating form when trainees are observing and critiquing others' role playing. These forms are usually simple, but they provide a record that can give feedback to the trainees (Figure 3).

Instructors/subject matter experts. The principal instructor for the program is the department's Training and Communications Coordinator. In addition, the Coordinator calls upon other department staffers with particular expertise. For example, a different person presented each of the lessons in the General Information unit: the

Assistant Director for Maintenance and Operations presented the lesson on the department's organization; the Manager of Building Maintenance and Operations presented the role of the first-line supervisor; the Manager of the Business Office presented the budgeting lesson; the Manager of Service Stores presented purchasing and receiving; and the Manager of the Operations Center presented the lesson on job requests and work orders.

First-line supervisors also contribute to lesson planning and in-class presentation. In particular, we call on the supervisors of the trainees' work areas to participate in class as subject matter experts, critiquers or presenters. We also bring in specialists from other parts of the university. For example, the Manager of Employee Relations in the Personnel Department helped to develop and present two lessons on the university's personnel policies.

The other major source of subject matter expertise is existing reference material - books, pamphlets, handbooks, guides, newsletters, audiovisual materials, etc. The key to their use is that they must be relevant to the department's situation. We adapt generic materials by developing examples that pertain to our workforce. We always try to link theories and concepts to reality and on-the-job requirements. That means drawing on the trainees' experience to validate and expand on any general information presented in class.

Classroom methods. As mentioned earlier, the classes combine several instructional techniques. When there is an information load, we use lecture, which is usually followed by an opportunity to apply that information in a case study or some other exercise. When skills are the subject matter, trainees get a chance to practice those skills in class, either individually or in role plays. Instructors use overhead transparencies a lot, since they are easy and cheap to prepare and can be effective for outlining concepts and summarizing content when prepared using commonly-accepted message design principles.

We videotape most of the lessons involving role plays and trainee presentations. The video operator is an advanced telecommunications student working on a part-time paid basis. The Coordinator briefs the operator before the classes. The staff and the trainees can use the class tapes for reference, either in class to validate or illustrate critiques, or as a review if trainees want to prepare for a test or see how far they have come. We also intend to produce a retrospective tape that consolidates parts of the curriculum at the end of the first program. We do not intend to re-use the tapes.

Program Evaluation

Trainee progress. One indication of the success of the program is the trainees' accomplishment of the instructional objectives of each lesson. As noted earlier, out of all the lessons presented there have been only a few instances where a trainee did not achieve the seventy percent success level on the evaluation component. The scores for a lesson generally show a normal curve among the trainees, although the position of any one trainee on the curve will usually vary with the subject matter in a relatively random manner.

Trainee participation. In-class participation, including attendance and punctuality, is also a good indicator of the perceived value of training. As of this writing, the attendance rate is 98 percent. Trainees are almost never late to class. If they know they are going to have to be absent, they invariably tell the Coordinator in advance and ask if they can arrange a make-up. The answer to that question is usually "no". Since much of the substance of the class comes from participation during the class, it is difficult to offer a make-up option. On occasion, if the evaluation device for the class is to be a test, the Coordinator offers the trainee who must be absent the chance to study the printed material for the class and then take the test after the rest of the class has done so.

Trainee evaluations of the program. After about four months in the program, the trainees who had been acting supervisors met with management representatives to review their experiences. The trainees had many comments about both their supervisory roles and their classroom training. In general, they were very positive about the value of the on-the-job experience. They all agreed that they had not realized just how hard it is to be a supervisor. In fact, one of the Heat Shop trainees decided that supervision was not for him. He wanted to continue in the program, however, and we allowed that.

The trainees also wrote brief reports on their supervisory experience. Management encouraged them to make suggestions on how their areas could be improved. Many of their ideas showed a new awareness of the work involved, and a number of suggestions have been considered by management.

With regard to their assessment of the training, several of the trainees felt early in the program that there was too much homework. We realized that for some of them, schooling was far in the past, and their habits needed to be re-established. We did try to reduce the homework load somewhat, and have had no complaints for some time.

Many of their comments about the training were very positive. In particular, trainees noted that their communication skills had improved. They also learned the importance of listening and attending skills, in the context of job performance.

The feedback from the trainees at the end of this cycle of the program will enable us to revise the curriculum and training methods for the next class. We will use both instructor ratings from classes and the trainees' ratings of particular topics to modify the program.

Supervisors' evaluations of the program. Supervisors evaluated the trainees at about the same time as the trainees comments were obtained. Supervisors noted that trainees' attitudes had improved about their job performance. Trainees do a better job of communicating about their work assignments and are more thorough and accurate in completing their time tickets.

The manager of the craft shops also evaluated the supervisor trainees. His reports were generally positive. These interim reports are valuable for some mid-course corrections, but the more detailed post-completion evaluations will be of greatest use in program revision and in assessing candidates for supervisory jobs.

Future cycles of the program. Although the program is still in its first cycle - about two-thirds completed - we are encouraged by the results we have obtained so far. Front-line supervisors are one of the most important positions in the department. Supervisors deal with our customers, faculty, staff and students. They are in the public view, and what they do and how they do it determines others' judgments about the Physical Plant. Supervisors have more influence on our workforce than any other group of staffers. They affect workers' morale and productivity.

We have been lucky enough to have the commitment of top management in support of the Presupervisory Training Program. That has been essential. Now that we are in full swing, it is becoming clearer that the program will serve our needs for some years to come. We intend to continue to use it as the primary vehicle for upgrading our supervisory staff.

We also intend to use the PTP as a model for training our current supervisors in areas they may need to review. It will be easy to adapt the curriculum and lessons to account for the greater experience of current supervisors.

Indiana University Department of Physical Plant

Presupervisory Training Program

CURRICULUM TOPICS IN SEQUENCE:

General Information

How the university is organized.
How Physical Plant is organized.
The role of the foreman.
IU and Physical Plant budgeting.
Purchasing & Receiving.
How job requests and work orders are initiated, processed, and completed.

Communication Skills

How to make a presentation.
IU personnel policies.
How to listen.
How to get good information from others.
How to give instructions.
How to keep records and complete office forms.
How to write memos and reports.

Interpersonal Relations

How to work with customers.
How to handle anger (others' and yours) and conflict.
How to be assertive.
How to manage stress.

Organizing Skills

How to set short-term and long-term goals for your work unit and yourself.
How to use time.
How to manage multiple demands on your time.
How to delegate responsibility.
How to involve employees in decision-making.

Shaping Job Behaviors

How to improve others' performance.
How to work with women and other minorities.
How to handle employee complaints/grievances.
IU safety policies.
How to work safely.
How to do on-the-job training.
How to conduct meetings.

- Figure 1 -

Presupervisory Training Program **Lesson #14:** Lesson Plan
Unit: Communication Skills
Lesson Title: Getting Information in Conversations

* *

1. **Instructional Objectives:**
   * Given a work situation as a supervisor in conversation with an employee, get information that helps to solve a work-related problem.

* *

2. **Instructional Materials:**
   * OT's.
   * Handouts.

* *

3. **Equipment & Supplies:**
   * Video-camera and recording equipment.
   * OT projector and screen.

* *

4. **Procedures:**

- -

Instructor:	Present objective and rationale.	5 min.
Trainees:	List situations requiring getting information on the job (as supervisor).	5 min.
Instructor:	Describe questioning techniques.	10 min.
Trainees:	Write an example of five how-to question techniques. Read to group.	10 min.
Instructor:	Describe note-taking techniques.	10 min.
Trainees:	Practice taking notes with each other.	15 min.
Instructor:	Describe paraphrasing.	5 min.
Trainees:	Practice paraphrasing with each other.	10 min.
Instructor:	Describe prompting.	10 min.
Trainees:	Practice prompting.	15 min.
Instructor:	Explain being silent.	5 min.
Trainees:	Practice being silent.	5 min.
Instructor:	Explain practical exercise assignment.	5 min.
Trainees:	Develop practical exercises in pairs.	10 min.
Trainees:	Perform practical exercises. Evaluate performers.	40 min.
Instructor/ Trainees:	Critique practical exercises.	20 min.

* *

5. **Evaluation:** **Practical exercise.**

3 Hrs.

- Figure 2 -

Presupervisory Training Program

Lesson #14: Practical Exercise Checklist
Unit: Communication Skills
Lesson Title: Getting Information in Conversations

* *

For each question below, rate the supervisor as:

0 - not at all
1 - some, but not enough
2 - sufficiently

Supervisor:_____

__**a**. ask "W" questions?

__**b**. ask probing questions?

__**c**. ask suppose questions?

__**d**. avoid the third degree?

__**e**. elicit feelings and opinions?

__**f**. get permission to take notes?

__**g**. take notes appropriately?

__**h**. paraphrase the employee's messages?

__**i**. use verbal prompts?

__**j**. use nonverbal prompts?

__**k**. use silence?

__**l**. make clear what information was needed?

__**m**. Do you feel the supervisor got the needed information?

__ **TOTAL**

Your Name:_____

- Figure 3 -

Performance Evaluations: A Positive Experience

Katie Smothers
Business Manager, Physical Plant Services
University of California/San Diego

I JOB DESCRIPTION

All of us at one time or another have been evaluated. It began in school where we were required to accept the instructors rated opinion without reason or rebuttal. For most of us it is this background we draw upon to provide evaluations for staff.

In order that we become effective supervisors and managers it is essential we provide a healthy environment for employee development. Without question the evaluation process is a major focal point in creating this environment.

Several key elements play a role in this process such as the:

(1) Job Description
(2) Documentation
(3) Narrative Construction
(4) Narrative (eliminate confrontation)
(5) Future Plans and Actions

The evaluation is based on the presumption that staff has been provided feedback relative to his/her performance during the previous evaluation period. In other words, "there are to be no surprises". Communication between staff and the supervisor will afford the staff member an opportunity to enhance strengths and if needed improve performance.

The evaluation also ties back to the "Job Description". This document was used as the source document for recruitment and selection. It now becomes key to a successful evaluation process. Utilizing the job description in conjunction with the annual evaluation provides the supervisor an opportunity for periodic review and update.

II DOCUMENTATION

At the time of the evaluation, a supervisor will be prepared to document justification of any ratings indicating a less than satisfactory performance. This maybe in the form of memos to the employee and/or file, samples of work, a calendar indicating dates and time of discussions, etc. Ratings citing an outstanding performance must cite specific aspects of performance as well.

It is strongly recommended the supervisor review with their appropriate manager the formal evaluation prior to meeting with staff. To ensure success the evaluation must be conducted one on one between the supervisor and the staff in a confidential environment. This will provide an opportunity for interaction and clarification.

III NARRATIVE CONSTRUCTION

In addition to standard ratings a constructive evaluation must contain a written narrative. The construction of this narrative is important to the psychological acceptance by the employee. Following, in order are the three main categories of the narrative:

(1) Positive comments,
(2) Areas of performance where the individual has the greatest opportunity or potential for improving or must improve,
(3) Goals and/or recommended training through the next evaluation period,

Note: Experience has illustrated the need to address attendance as a specific issue. This places the department in a proactive position relative to productivity and potential disciplinary actions.

IV NARRATIVE (eliminate confrontation)

While the evaluation is a task most supervisors find less than desirable it is the most important task performed for the employee. It must be given official status. It must be treated as though it were a document being routed to the Chancellor.

Confrontation must be eliminated. Rapport between the supervisor and the employee must be established. Even though it may seem awkward some level of formality is required. First person dialogue is eliminated and instead the record is addressed, ie.,

IMPROPER

> "Melvin, this past year your performance has been ok. You continue to use good maintenance standards. I think your attendance is ok."

PROPER

> "During this past year Mr. Samples performance has been satisfactory. He continues to perform maintenance tasks using established procedures. Mr. Samples attendance is at acceptable levels."

Placing emphasis on performance rather than the person eliminates confrontation. This further enables the supervisor to effectively discuss areas requiring improvement.

V <u>FUTURE PLANS & ACTIONS</u>

As an effective evaluator and supervisor, setting future plans and actions are a must. This would include any areas in the evaluation cited for improvement, position related training, education and/or identified goals.

IV <u>TIMING FOR SUCCESS</u>

In addition to the process discussed above one major issue remains to be addressed and that is "timing for success".

In every organization the element of timing becomes critical. There is never enough. Most of our supervisors have several staff to supervise meaning an equal number of evaluations. Can we expect them to stay on top of this in addition to daily operations? Do we as managers have a responsibility to assist them in this area?

The most effective method for success demonstrated to date is where the department personnel unit or an individual is responsible for:

(1) Initially sending out evaluation notification 30 days in advance of the due date.

(2) Including with the notification a copy of the most recent job description, and a copy of the last evaluation. (This provides the supervisor all the tools needed to proceed.)

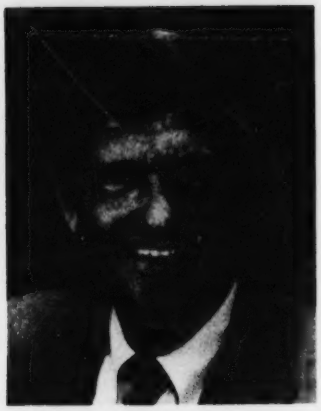
(3) Follow-up. Should the evaluation not be received by the personnel unit or individual responsible an overdue notice is sent to the evaluators supervisor and manager the next day following the expired due date.

In the event this fails to solicit a response another notification is sent 10 days following the second notice. This notice is addressed to the department director and division manager.

Following this or similar process indicates to the supervisor as well as the employee the importance of the employee to the department.

SUMMARY:

It is anticipated this method of evaluation will provide a **"Positive Experience"** for all future Employee Performance Reviews. Good luck!



There is a Dual Purpose in Motivation

George B. Wright
President
The George B. Wright Company

Introduction.

A description of motivation: "It is the discovery of some basic human emotion, impulse or need that is strong enough to culminate into action." Every person is an individual - there is no such thing as identical twins - where emotion, impulse or needs are concerned. Our people are different ages, sexes, come from different family influences, different education levels, have different interests. What can we do to motivate a group? The answer is we must have simultaneous activities on-going all the time, so any individual can find something that is a stimulus to him or her. No one activity will suffice.

But - this brings us back to our title "There Is A Dual Purpose In Motivation." Here is the dual purpose. We must do the work that has to be done but, at the same time, we must give the employee a sense of self-worth and usefulness. There is a fabulous balance here, and any Leader, Manager or Supervisor needs this balance. There should be no apology made for work, as long as the employee is treated with dignity doing that work. There is no apology made when the employee is tired at the end of the day, as long as we have treated the employee with consideration and dignity.

Other parallel illustrations that emphasize the dual relationship in the workplace -

(1) It is both Performance & People.

(2) We can be loose & tight - fair & friendly vs firm & factual.

(3) We document both the good & bad.

A. The limitations in motivating Physical Plant employees.

There is no tougher challenge in the area motivation of employees than the Physical Plant because we are not able to:

(1) Give immediate raises.

(2) Give bonuses.

(3) Give individual incentives through contests, prizes, etc. based on performance.

(4) Give group (departments) incentives based on performance.

B. What do employees want to receive from the workplace?

Fair Pay

(compared to similar jobs in other institutions).

Security

Fringes, plus working for an institution/business that is stable and not going out of business.

Opportunity

To progress upward in the organization.

Participation

A chance to be a part of decision-making.

Recognition

"Give the employee a sense of self-worth and usefulness."

C. Recognition - Expanded.

(1) Use of names in proper way.

(2) Uniforms for all employees.

(3) Employee-of-the-month.

(4) Employee anniversary letters.

(5) Service pins.

(6) Newsletters.

(7) Perfect attendance.

C. Recognition - Expanded (continued).

(8) Suggestions and ideas.

(9) Notes of appreciation.

(10) Being visible in the workplace - visit all shifts.

(11) "Pride of Performance" awards.

(12) Annual picnic or Christmas party - include retirees.

(13) Pictures of employees doing their jobs - put in halls or offices - change them every 30 days.

(14) Set up a training area (room).

(15) Offer a program of self-improvement through training education.

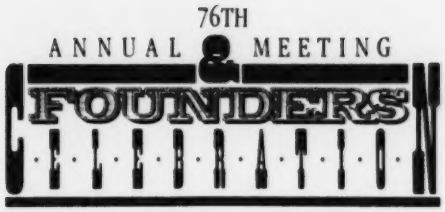
(16) Business cards to Supervisors.

D. This should be the era when human resources rather than natural resources are the well - spring of health, vigor and greatness.

(1) Help someone else grow and develop. You did not get where you are completely alone.

(2) D.U.C.B. -- Develop - Unfold - Change - Become.

Work & Self-Worth - Dual Influences in Motivation.



Plant Operations and Maintenance

APPA Study—Custodial Staffing Guidelines

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At the bottom of the page on every Association of Physical Plant Administrator's (APPA) letterhead, there is a sentence which reads:

> An association, international in scope, founded in 1914, whose purpose is to develop professional standards in the administration, care, operation, planning and development of physical plants used by colleges and universities.

The Custodial Staffing Guidelines Research Study is a "grass roots" attempt by Physical Plant Administrators from around the country to develop one set of such "professional standards."

Background The idea of establishing a set of Custodial Staffing Guidelines is one which has been discussed for years. Formulas have been developed, plans have been devised, seminars have been presented but, a series of standards upon which to base recommendations has yet to be endorsed by any substantive group. The idea of forging ahead under the umbrella of a national association's banner was hatched at the Midwest APPA (MAPPA) meeting in the Fall of 1986 in Grand Rapids, Michigan. With the encouragement and promise of support by APPA Executive Director, Walter Schaw, we forged ahead.

The first official recognition of this effort was provided at the 1987 annual Spring meeting of the Big Ten and other Midwest University Physical Plant Directors. Fred Garcia, of the University of Illinois at Chicago, proposed the establishment of an ad hoc committee to study the subject. The conference call for volunteers was answered by three Universities: Illinois at Chicago, Wisconsin-Parkside and Minnesota-Minneapolis.

A direction evolved, the concept began to be fleshed with ideas. Words such as service levels, types of buildings, expectations and first class began to jell. A matrix combining service levels with types of buildings was developed which has formed the nucleus for this study.

A pivotal point was reached in the Fall of 1987. The concept and direction was presented to the Big Ten Conference on Custodial Care at Iowa State University and MAPPA at its annual convention in Indianapolis, Indiana. The reception at both locals was enthusiastic. APPA's 1987-1988 President H.C. Lott and President-Elect Dorsey Jacobs were both present at the experience exchange in Indianapolis where this concept was discussed in detail. H. C. Lott suggested a research study proposal be prepared to which Dorsey Jacobs promised support. That proposal was presented at and approved by the January 1988 meeting of the APPA Board of Directors.

Organization The truly "grass roots" nature of this Research Study is highlighted by the flow rather than chart of organization. It is a series of committees which interact around the charge of developing Custodial Staffing Guidelines. It is the interaction of ideas which has stimulated the dynamics of this Research Study. There are no Committee Chairs or tiered organization charts. The organization is a series of committees comprised of the leaders in the industry striving to develop one set of "professional standards" - the APPA goal of 1914.

The Operations Committee is at the center of the Organizational Flow. It coordinates the activities of the various committees, provides the forums for discussion and debate, develops the resulting ideas and directions into a written format and reports the various committee activities to APPA. This is the keystone of the Organization Flow.

The Advisory Committee is the panel of experts, the leaders in the field. It is composed of twenty-four APPA Institution members representing the six regions, delegates representing six national/international associations concerned with custodial operations and two delegates representing employees. This committee sets the direction and scope of the study. These experts, the structure, determine the foundation upon which these staffing guidelines will be constructed.

The Support Committee is the largest and currently counts over one hundred members. This group is tasked with testing the concepts and directions. They provide the data upon which to base the guidelines and thus forms the foundation of the study. This group is open to additional membership. The only requirement is that they be responsible for custodial operations and be willing to provide the data requested.

The Employee Involvement Committee is a totally new direction in national commitments providing the balance to the structure. It is the first attempt, on a national level, to form a group of employees into a deliberating and endorsing body. This committee and its members are encouraged to engage in open and frank discussion of the same subjects as the Advisory Committee. They are also asked to forge into any area of

discussion which may lend support to the development of Custodial Staffing Guidelines. They have two representatives which act as delegates to the Advisory Committee to insure an employee outlook is considered in this research study.

Direction At this point in time, the Advisory and Employee Involvement Committees are in complete agreement with the establishment of Custodial Standards and Expectations and great enthusiasm has been shown by the Support Committee. The standards are established through development of a series of service levels for each type of area to be cleaned. The second level in each instance being the standard to be recognized and recommended by APPA. From these levels of service, expectations are developed which must then be relayed to the campus customers. This process insures that, whether satisfied or not, everyone is "reading from the same sheet of music."

Another subject which has caused a great deal of concern resulting in much debate is the uniqueness of each institution. Location, weather, clientele and a myriad of other variables has been the stumbling block which has prevented agreement in the past. It has almost stalled this endeavor. Our combined consensus is to consider the common characteristics within this study. That is to say, establish the levels of service required to clean a washroom facility without the oddities unique to an individual institution. That is not to say those variables will not be recognized. They will be addressed as factors which could affect an individual campus but must be applied as circumstances dictate. In some instances, they may not even be applied as they tend to become a subject which "muddies the water" and detracts from the primary message of this study.

Purpose What is the primary message of this study? What is the purpose behind this effort? It is an attempt to establish a common denominator. A common denominator which may be endorsed by one or more national associations as either a series of guidelines or set of standards to be utilized by individual institutions as a base. There are two key words in that statement. The first is the word endorsed and the second base. Without endorsement of a recognized standard or guideline, there is no base upon which to build an argument or set a direction - only shifting sands.

Once complete, a pamphlet will be developed which may be used as a tool to show where an individual institution stands, not in relation to other but, in relation to nationally (possibly international) recognized guidelines or standards of service. It may be utilized by a Crew Leader and Worker to set work schedules and cleaning requirements. It may be utilized by a Manager or Supervisor to set staffing levels or establish expectations with a Department Head. It may be utilized by an Administrator to show a legislative committee the cost of a budget cut or to determine a logical reinstatement of services.

Future The last meetings of the Employee Involvement and Advisory Committees were in February and March of this year. The final decisions on variables, levels of service and time standards were reached at those meetings and the Operations Committee was tasked with developing devices

to utilize those time standards in developing a data base to fill in the Levels of Service Matrix. Questionnaires and survey sheets are now in final draft and will soon be sent to the Support Committee members. Over the next six to nine months, they will be collected, interpreted and developed into the Levels of Service Matrix which will be presented next Spring for endorsement to the Advisory and Employee Involvement Committees. Their recommendations will then be forwarded to the APPA Board of Governors for approval and recognition. The delegates from each of the national associations will also be asked to present these standards to their individual boards for approval and endorsement of an APPA Standard.

Goal The goal of the Operations Committee is to print that pamphlet detailing Custodial Staffing Guidelines by the Fall of 1990. We hope to meet that challenge of 1914 through the development of these "professional standards in the administration, care, operation, planning and development of Physical Plants used by Colleges and Universities..."

McBride

Stephens

Managing Roofs: A Case History at Oregon State University

Richard L. McBride
Principal Architect
Soderstrom Architects, P.C.

John L. Stephens
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Oregon State University

The Problem at Oregon State University

Our campus of 530+ acres is that of a Land Grant Institution founded in 1887 with the construction of our oldest building, Benton Hall. This building was built by the citizens of Corvallis for $77,434 and was donated to the State as our first college building. Benton Hall was constructed with a simple wood frame structure utilizing full dimension, rough sawn 16" X 3" timber joists of knot free clear straight grain lumber milled from our local timber.

Over the years, our campus has grown to our present total of more than 100 academic and research buildings plus a significant group of buildings for student housing, student activities, and student health. An additional group of agricultural, farm, forestry, and extension service buildings are not included in the above total. Of course, our buildings are of widely diverse architecture, materials, and construction quality in addition to their diverse ages. The roofing systems range from the steep pitched shingled semi-mansard roof on Benton Hall to the common built-up flat roof systems found on many of our older roofs.

The great diversity of building and roof designs has resulted in a very difficult maintenance and repair situation. In addition, our funding situation is no better than most similar institutions so that deferred roofing maintenance has been a growing problem in recent years.

We are part of the Oregon State System of Higher Education which includes eight institutions competing for funds from the state budget. The state of Oregon operates on a biennial budget system with the fiscal year beginning July 1 each year.

Each institution has its own president and administration with its own academic and operating budget. Our budgets for routine operating and maintenance funds are a part of this stream of funds. A second stream of funds involves the capital repair and renewal budget made available through the Board of Higher Education to accomplish major renovation, repair and replacement projects. This includes roofs as well as sewers, streets and utility systems. This arrangement of administrative and budgeting systems makes decision making a rather slow and tedious process. Obviously, the best time to obtain good bids for reroofing contracts occurs in the early spring and late winter, beginning in February. This is the time that the best qualified roofing contractors are bidding for work to fulfill their summer work load needs. You can easily visualize the problems and conflicts between this need and the state and institutional funding calendars. Therefore, considerable advance planning and design work must be done to overcome this situation. We do this by various advanced planning strategies.

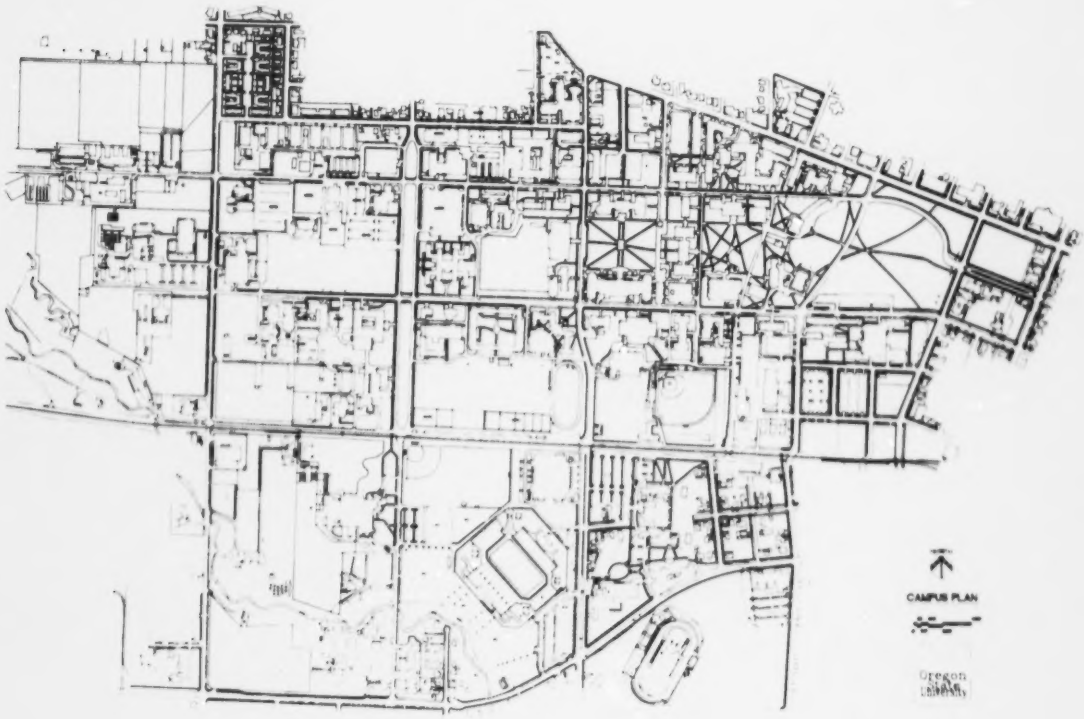
Oregon State University's goal is to provide the best and most cost effective education possible for its 15,000 plus students. At the same time, it has a responsibility to administer a major research program which competes for funds, other resources and space. This means, of course, space which does not have leaking roofs, if possible.

As you can see from the above description, with buildings constructed over a time span exceeding 100 years and by virtue of architectural, materials, and construction technique differences, we cannot choose across the board application of any single roofing system. In addition, varying parapet, penthouse, and cornice designs along with related rain drain designs seriously complicate the problem. Materials such as untreated wood supports inside metal cornice and fascia trim invariably become wet, rot, and fail over the years. Thus, we seldom have a simple roof replacement job. Usually, as much as 25 percent to 50 percent of our total budget for a reroof project must be spent on restoration of these features before the roof can be replaced. Never-the-less, over the years much of this hidden work has been ignored or only partially corrected. Therefore, our recent roof work has increasingly involved this type of related work.

The above problems are common, more or less, to all institutions of higher education in the U.S. However, we in western Oregon and Washington face what we believe to be a unique weather situation especially in the Willamette Valley. Our facilities, especially their roofs, handle a large amount of rain water and long term high humidity. This accelerates deterioration of roofing materials and substrate materials as well as the support structure, in many cases. It causes rot and mildew as well as the ever present growth of moss and algae on the wet surfaces and in all crannies and crevices of the roof surface. This, combined with the heavy and prolonged leaf fall from the exuberant growth of our campus trees causes any leak, however minor, to be a problem. Thus, eight to nine months of rainy weather means that we must cram all of our roof replacement contract work and major repair work into the three to four summer months. Fortunately, we do not have the weather extremes and snow loads many other U. S. campuses experience.

Thus, our problem includes a large variety of deteriorating roofs, not enough funding, no consistent roof management plan, and a need to protect our multi-million dollar investment in roofs. Amplifying this problem is the

growing demand of our faculty and student body for more dry leak-free space. A related factor complicating our problem is the newly emerging high technology roofing materials, roofing techniques as well as the ever changing contracting situation.



The Solution at Oregon State University

By 1984, roof problems at Oregon State University had reached the point where new approaches were necessary in order to avoid real trouble. Recognizing this fact, officials at the University embarked upon a new three-part program, intended to improve roof management practices, improve preventive roof maintenance and repair procedures, and replace a large backlog of aging and defective roofs.

In 1984, the Oregon Legislature substantially increased funding for deferred maintenance projects within the Oregon State System of Higher Education. Oregon State University received its share of those funds and immediately took steps to improve its replacement program. The objectives of the program were established to (1) maximize the benefits of the competitive bidding process, (2) improve the overall quality of the product received by the University, and (3) maximize the value received by the University.

Competitive bidding of public construction projects is required by law in the state of Oregon. Competitive bidding can, and often does, lead to awards to low bidders who may or may not be as qualified as required. On the other hand, competitive bidding encourages healthy competition and best value to the University, qualities that we chose to enhance. In order to maximize

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the advantages of the bidding process, 1984 reroofing projects were designed during the winter months and bid during the months of February, March, and April, when contractors are looking toward their Oregon summer work load. Materials and methods were carefully selected to fit existing buildings and encourage "apples-to-apples" bidding by qualified contractors. Bidding packages were carefully conceived and well detailed to present a clear and concise picture to bidders of what was expected as a finished product.

Maximizing the advantages of bidding is one part of the overall strategy of improving the quality of constructed roofing projects. Improved design and material selection are equally important. Oregon State University Physical Plant Department is made up of many diverse building types of all ages and styles. Each building must be dealt with from a design point of view on an individual basis. Design issues such as code, fire and safety requirements, insurance requirements, structural implications, special details, equipment, energy conservation, cornices, parapets, walls, access, disruption, and all kinds of other issues must be considered on each building. In order to maximize the effectiveness of good design, Oregon State University has chosen to use outside consultants for design work and to prepare bidding documents. Bidding, contract administration, and inspection services are provided by Physical Plant Department personnel with assistance from the design consultant.

Oregon State University is responsible for providing many services to its students and the people of the state of Oregon. It is charged with doing so in as economically effective way as possible. Building improvement projects must also maximize value to those it serves. Each project must be designed to maximize value to the University. A life cycle cost analysis and a risk analysis is provided on each reroofing project to make sure realistic budgets are established and met.

The second part of the new roofing program involved upgrading the preventive maintenance and repair program; the goal being to increase the effectiveness and efficiency of the program and, thereby, improving the life cycle performance of all the roof assets of the University. The basic elements of the program were established as: (1) systematize inspection, maintenance and reporting procedures, (2) interface with the roof management plan data base, (3) develop a maintenance manual for each basic roof system being maintained by the University, (4) implement an ongoing training program, and (5) establish a roof maintenance staff.

Oregon State University is comprised of many buildings with many different types of roof systems of varying ages. Diversity and flexibility is the key word. Roof materials include cedar shingle and shake, asphalt shingles, clay and concrete tile, slate, standing seam copper, zinc and steel, all types of asphalt BUR, coal tar BUR, modified bitumen systems, and ballasted and adhered EPDM.

The most important part of the overall roof management program was the decision in 1986 to improve roof management practices by developing and implementing a roof management plan. The objectives of this plan were to (1) improve communication among the various groups involved in the budgeting process, (2) improve planning, scheduling and budgeting process, (3) develop tools needed for efficient, effective, and productive management of roofs, and

(4) identify staff and equipment needs.

Like most public institutions, budgeting for major projects, including deferred maintenance, is a political process involving the state legislature, the State Board of Higher Education, the Oregon State University Administration, the Physical Plant Department, and the end users such as the College of Engineering or the History Department. The legislature must be convinced of the need to appropriate funds, the State Board of Higher Education must coordinate the needs of all the state institutions, the University Administration allocates resources according to need (and sometimes other pressures), and the Physical Plant Department must spend those resources wisely while providing design, engineering, maintenance, and consulting services to the end user groups. The entire process is accomplished within the framework of a biennial budget system.

The development of a roof management plan at an institution of the size and complexity of Oregon State University is a massive undertaking. Four basic tasks were necessary in order to provide the information necessary to implement the plan.

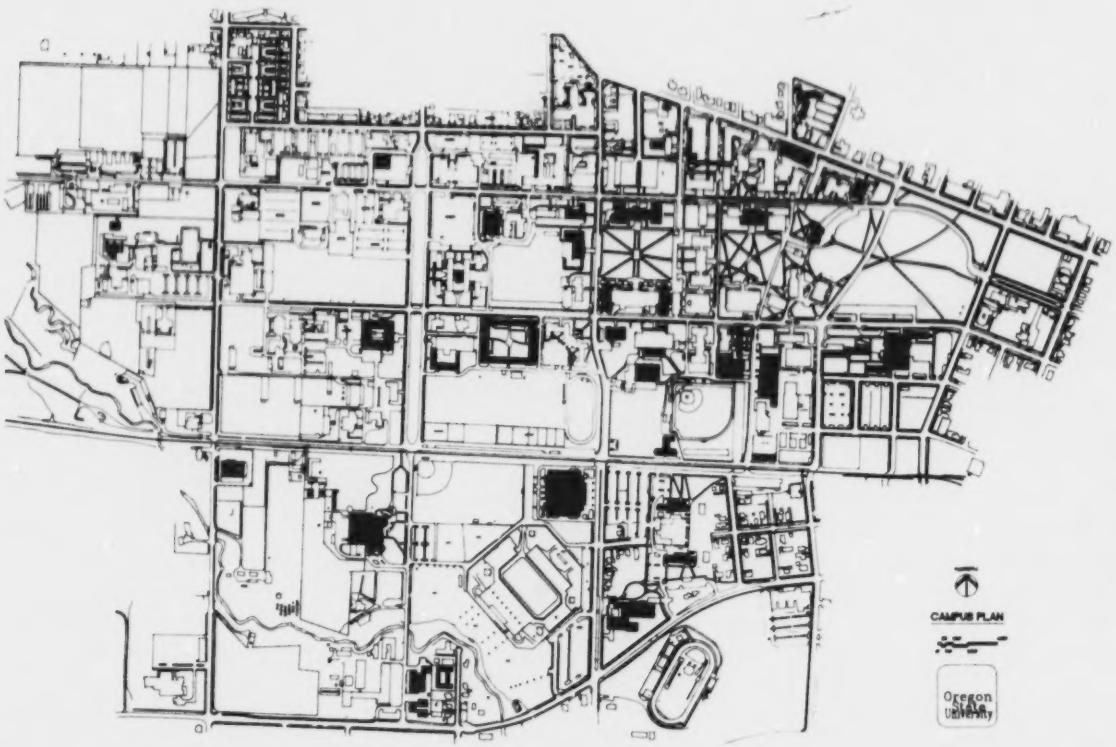
The first step was a three phase inventory of existing roof related conditions for all the buildings administered under the budget for academic buildings. Other University buildings, such as dormitories administered by Housing and Food Service have not, as yet, been included in this inventory work. The purpose of this inventory work was to develop a suitable drawing and data base. The first task included field investigations, selected moisture surveys, photography, review of record drawings, identification of the need for special testing, structural analysis, etc., and interviews with staff. The second task was evaluation of the information gathered and included estimates of life expectancies, value analysis, priorities, and special considerations. Priority replacement projects were also identified during this part of the work. The third key task was to identify the special needs of each building, such as special mechanical considerations and damaged building components like structural decks, parapet walls, cornices, etc. Each building roof was considered for energy improvement possibilities. Underwriters Laboratories and Factory Mutual requirements were also evaluated. The fourth task was to develop the management tools required to manage all the information and, therefore, the roofs. The Oregon State University Physical Plant Department is committed to automation to manage the many functions of the department. Hardware in place includes three IBM AT-based computers running AUTOCAD and other software programs. The roof management plan will be applied using these systems. The data base includes roof plans, schedules, budgets, and a program of action for each building.

Progress at Oregon State University

Progress has been made on all three fronts of the roof management program at Oregon State University. Significant progress has been made as a result of this roof management program with the identification and prioritization of deferred replacement projects. Appropriate designs and contract bid packages have been completed for a major part of the projects identified. However, funding is lacking for their implementation and a backlog is waiting in the gate for funding. The improved preventive maintenance and repair program is in its infancy, with the first stages of training now underway. The

management planning process was funded in three phases beginning in 1986, and is about 50 percent complete as of this date.

Each year the University has budgeted funds to replace, and sometimes repair, roofs. The campus plan included in this paper indicates the progress that has been made since 1984. The graphs that are also included indicate the actual expenditures made for academic building projects and for all University buildings. The budget categories include legislative-funded academic buildings, fee-funded housing and food service buildings, fee-funded student services buildings, and miscellaneous other independently funded buildings. Energy upgrades have been accomplished where appropriate. Repairs to, and restructuring of, cornices and parapet walls have been accomplished when necessary. In some cases, needed structural repairs and even restructuring have been accomplished.



The preventive maintenance program has a long way to go before it can truly become effective. Training sessions have been given to the building trades' staff, with EPDM maintenance and repair procedures being the first. Several repair projects have also been identified and accomplished. Oregon State University sometimes chooses to contract out larger repair projects depending on size, complexity, and availability of manpower.

The management plan development has progressed into the second of three phases of work and is nearing a point where certain parts of the plan can be implemented. Field work is at 33 percent; review of record documents at 67

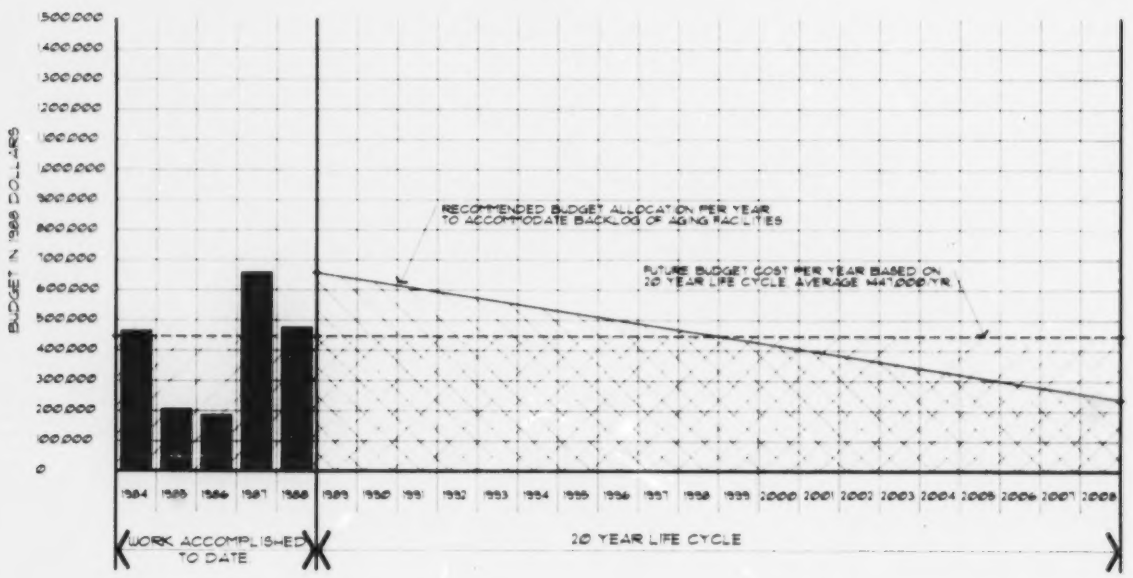
percent; priority project identification at 90 percent; preventive maintenance interface at 10 percent; scheduling and budgeting at 33 percent; and establishment of an effective interfacing reporting system at 10 percent. A number of related benefits have already been realized, some unanticipated. An interim report which included the following overall budget information caused all kinds of new communication to be established...all the way to the legislature.

	Replacement Value	Value/Yr.	Area
All Oregon State University Roofs	$13,200,000	$660,400	1,630,820 SF
Academic Roofs	8,931,000	447,000	1,218,733 SF
Housing & Food Services	1,519,000	75,900	206,875 SF
Student Services	985,000	49,250	117,509 SF
Other Roofs (known)	565,000	28,250	87,703 SF
Other Roofs (unknown)	1,200,000	60,000	---

PAST AND PROJECTED BUDGET NEEDS FOR REROOFING OSU ACADEMIC BUILDINGS

OSU ROOF MANAGEMENT PLAN

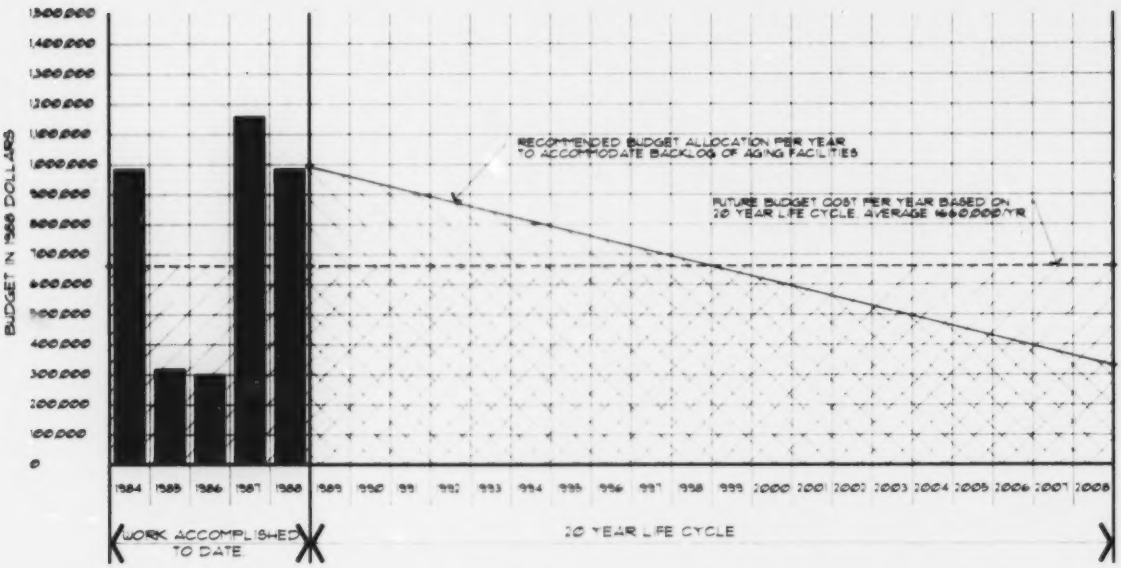
SODERSTROM ARCHITECTS P.C.
320 S.W. Stark Street, Suite 690 Portland, Oregon 97204



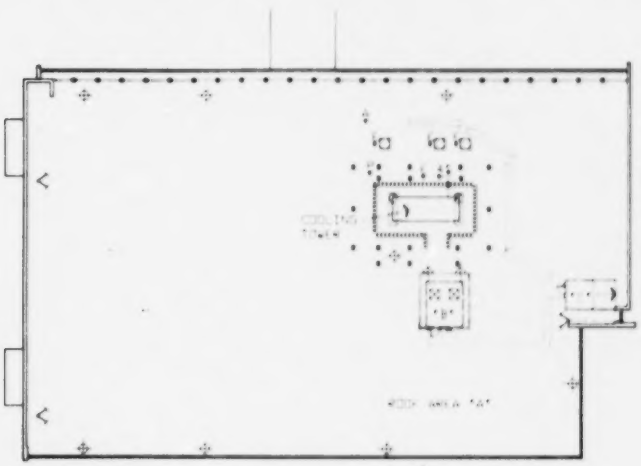
PAST AND PROJECTED BUDGET NEEDS FOR REROOFING ALL OSU BUILDINGS

OSU ROOF MANAGEMENT PLAN

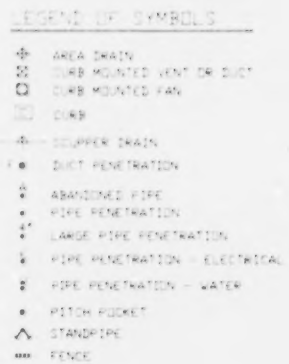
SODERSTROM ARCHITECTS P.C.
320 SW. Stark Street, Suite 650 Portland, Oregon 97204


BUDGET IN 1988 DOLLARS
RECOMMENDED BUDGET ALLOCATION PER YEAR TO ACCOMMODATE BACKLOG OF AGING FACILITIES
FUTURE BUDGET COST PER YEAR BASED ON 20 YEAR LIFE CYCLE AVERAGE
1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
WORK ACCOMPLISHED TO DATE
20 YEAR LIFE CYCLE

The roof plans have been used for inventory work as well as for some reroofing projects. The plans are accurate and include symbols describing the nature of all edges, separate roof areas, and penetrations. Since they have been developed using AUTOCAD, they can easily be plotted and used at any desired scale. The Kerr Library roof plan is an example of computer-generated plans now being used by Oregon State University.



ROOF PLAN
1"=30'-0"
SCALE IN FEET



KERR LIBRARY
(Building No. 36)
LATEST UPDATE: 10/28/88 87115036

Future Objectives at Oregon State University

The first objective is to complete the management planning process and get all phases of the roof management program fully implemented.

A second objective is to fully integrate the data base with the graphic data (roof plans) to maximize our ability to efficiently schedule, cost estimate, conduct detail take-offs, and interface with the preventive maintenance program.

The third objective is to include new buildings in the system while they are still in the planning and design stages of development. A design objective at Oregon State University is to make sure that roofs on all new buildings have positive drainage.

While much has been accomplished during the last five years at Oregon State University, much remains to be done. What has been accomplished is working effectively, and the program is now approaching the "hump." We are now looking forward to getting over the hump and really managing our roofing problems in the most efficient and effective way possible. Our experience convinces us that the graphic information and results of this program is our best bet to obtain necessary funding and support at all levels in our state for elimination of our deferred roof replacement backlog. Once funding is available, we know that this program will allow us to manage it most effectively.

Single-Ply Roofs: Eight Years Later

Dennis P. Cesari, P.E.
Director, Facilities Planning & Development
University of Missouri System

In 1981 the University of Missouri System began installing single-ply roofing systems. At the time there appeared to be a high probability of success with these systems versus the old built-up roofing systems. The use of these new systems increased dramatically in the early 80's and as a result many roofing manufacturers entered the single-ply market place.

In 1983 the University of Missouri developed Design Guidelines and Pre-qualification Procedures for the use of single-ply roofing systems. These procedures were developed because of the number of unproven roofing systems entering the market place and the apparent lack of knowledge in the architectural community, regarding these new systems. The development of design standards and pre-qualification procedures would, hopefully, increase the success rate on University facilities with these new roofs.

Also included in the University's Roofing Guidelines was the development of a University of Missouri Roofing Warranty. This warranty required pre-qualified manufacturers to warrant not only the roofing material, but also the roofing system, including insulation. Requiring manufacturers to sign this warranty also eliminated some of the less proven companies from working on University projects, as the small companies would refuse to sign this warranty.

Since 1981, the University of Missouri has installed single-ply roofing systems on approximately 90 buildings. Of the systems installed, all were ethylene propylene diene monomer (EPDM), except eight which were polyvinyl chloride (PVC). All of the PVC installations were ballasted, whereas the EPDM membranes were a mix of ballasted, mechanically fastened and fully adhered.

The University's Design Guidelines indicated an order of preference for roofing systems, with ballasted systems being the first choice. If the roofing structure could not support the ballast, the second alternative would be a mechanically fastened system. If the mechanically fastened system would not be

appropriate an adhered system could be installed. Furthermore, because of some early problems the University of Missouri had with some adhered systems and testing done on mechanically fastened systems, the University developed and designed their own mechanically fastened bar system, which was used on all mechanically fastened installations.

A survey was recently completed on all roofs installed on University of Missouri facilities since the University's design standards and procedures were put in place. The results of the survey indicated that, overall, ballasted and adhered systems have been very successful. The mechanically fastened systems, however, have been less successful.

Most of the roofing problems experienced are attributed to manufacturers that have discontinued their roofing products. EPDM roofing systems that have fallen into this category have been provided by Gates Rubber Company, Pirelli Tires, and Plymouth Rubber Company. Failures experienced with Plymouth and Gates systems have been with seam failures, primarily in the field seams, however also some factory seams also failed on the Gates system. The Pirelli system totally failed, as the material deteriorated.

The failure of seams on the EPDM system is the most prevalent problem. Manufacturers have been dealing with this problem since the inception of the EPDM systems and have improved cleaning and adhesives over the years. Neoprene bond contact adhesives, for instance, are no longer used. The PVC system installed under the University's guidelines have experienced a 100% success rate. These systems were installed with heat welded seams, as this was one of the University design standards. The seaming of the PVC systems is a major advantage over the EPDM system.

Another problem associated with the EPDM seams is the proper sealing at the edge of the seams. Many manufacturers recommend a caulking or sealant type of material be applied at the external edges of all seams. This is required to eliminate moisture penetration into the seam.

As a result of the recent study completed, the University of Missouri will be slightly modifying its' roofing design guidelines. The EPDM ballasted systems will continue to be the first choice for roofing systems, however the adhered systems will become the second choice. Mechanically fastened systems will be the third choice, and will only be recommended if there is sufficient wind uplift that would deem either of the other two systems inappropriate.

Additionally, the University will no longer require the use of the University's mechanically fastened bar system. Manufacturers of roofing systems have done extensive research since the early 80's and have developed new mechanically fastened that, it is believed, will properly support roofing systems. Several manufacturers introduced several different types of mechanically fastened systems through the 80's and have since abandoned these systems. Previous non-penetrating type systems, which appeared in theory to be superior, have proven to be noneffective in the roofing market. Most mechanically fastened systems now consist of a metal plate system with penetrations through the membrane to the deck.

The University will continue to use the University of Missouri Roofing Warranty as this has proved successful in eliminating some of the unproven manufacturers. Additionally, the University will pursue extended contractor warranties for up to five years which would greatly assist in the repair of the roofs after leaks are detected.

Additionally, emphasis should be placed on inspections by University personnel during the installation of the roofing system. Full time inspection of a roofing system should be considered, as most failures have occurred due to the workmanship by installers. A few additional dollars spent on inspection services could result in thousands of dollars saved in future roofing problems.

Maintenance of a roofing system should not be ignored. It appears to be the general operating practice that after a roofing system is installed, it is ignored until a leak occurs. Unfortunately, this type of operating practice only results in leaks and damage far greater than would have been experienced with a routine roofing maintenance program.

As a minimum, every roof should be inspected twice a year. Once in the spring and once in the fall. Inspectors should pay close attention to flashings and seams, where visible. Crews experienced in the repair of roofing systems should be available on each campus so that minor repairs can be made immediately. It should be noted, however, these crews should be certified by the manufacturers or the manufacturers notified prior to repairs being made by campus work crews. Failure to properly repair single-ply roofs may void the roofing warranty.

In summary, single-ply roofing systems have proven to be very successful. To date, the University of Missouri has experienced over a 90% success rate on EPDM systems and a 100% success rate on PVC systems. Only, as these systems continue to weather in time, will the true success be known. Some systems installed show little or no weathering, and may well perform for another 20 to 30 years.

Not all roofing systems, however, are equal, and one should evaluate each system and it's proposed applications before specifying. Design consultants should be challenged to determine the most economic system for a particular application and should be required to properly design the right system.

Institutional Waste Management

Edward C. Bogard, P.E.
Directer of Physical Plant
University of Nebraska Medical Center

In the mid 1970's our nation's colleges and universities were faced with the rising cost of energy and we reacted by initiating energy conservation measures that included immediate cut-backs in usage and revised design standards for future construction. Operating budgets were severely impacted for a time, but we gradually adjusted. Today we are hearing about the "sick building" syndrome and are being told it is a direct result of doing our job too well.

In the 1980's we were blind sided by asbestos and we are only beginning to see the financial impact of this legislation. Most of us saw asbestos fire-proofing applied at five cents a square foot and are now paying ten dollars a square foot to remove that same material. Federal legislation compounds the problem further because it severely restricts our ability to dispose of the asbestos when it is removed. If that is not bad enough, we are advised that we are responsible for the material we had removed if future legislature changes decide it is in the wrong place. Today's news contains stories about research that says the fiberglass we are now using to replace some of the asbestos with may pose even a greater health hazard.

It is my belief that these two issues are small by comparison if current impending legislation governing waste materials is enacted. Current active legislation such as the Comprehensive Environmental Response Compensation and Liability Act of 1980, as amended (called the Superfund), the Resource Conservation and Recovery Act, Section 7003 (RCRA), the Luken and Lautenberg Bills and the immense volume of State legislation currently being considered may well have a greater impact on our budgets than the preceding two issues.

The Environmental Protection Agency (EPA) was established as an independent agency on December 2, 1970. It was created to permit coordination and effective governmental action on behalf of the environment. As a compliment to its other activities of research, monitoring, standard setting and enforcement, EPA also coordinates and supports research and anti-pollution activities by State and local governments, private and public groups, individuals, and many of our colleges and universities. Their authority and reputation for brutal action has been felt by many of our institutions with fines running into the hundreds of thousands of dollars. Some experts feel this is only the tip of the iceberg and we may well see fines exceeding $1,000,000 as a normal routine. Private enterprise has felt their sting as witness the oil spill in Valdize, Alaska.

We, as representatives of our nation's colleges and universities, need to be aware of the potential financial implications for irresponsible actions and the opportunities that may exist which can reduce the direct impact on our already over committed budgets. In days gone by, we may have looked at everything that went out the back door as garbage regardless of where it came from. Many of us in the 60's had "back yard" incinerators in which we burned all of this unclassified refuse. With time, and changes in emission standards, we began either hauling the waste materials ourselves or contracted with commercial haulers to dispose of it, "in accordance with local requirements". As EPA began enforcing new rules and regulations and local authorities began to impose stricter standards, we were forced to look for other alternatives. Reclassification of many waste materials has resulted in a much closer scrutiny of what goes into our waste streams.

In a broad sense wastes can be classified as general office, infectious, hazardous and radioactive. Each one of these is further defined and in most cases if any of the more restrictive elements are present then the entire mass is classified by the more restrictive classification. Take the case of my institution. We are a medical center that does teaching and research while operating a 350 bed hospital. We generate approximately 11,000 pounds of general and infectious waste each day. We also generate approximately 725 pounds of hazardous and radio active waste each month. Consequently we are classified as a Small Quantity Generator by the R.C.R.A. definition. In 1983 a study was conducted on our campus to determine the most cost efficient means of disposing of our waste. An economic analysis indicated that we would best be served by building an incinerator to burn the general office and cafeteria wastes, infectious wastes, declassified radiated wastes and hazardous wastes with a BTU/pound content of 5,000 or more. The analysis substantiated the savings which could be gained by generating steam in the process. Early calculations predicted that the $900,000 incinerator investment would be amortized in approximately 4 years.

For the most part the predicted savings has been realized, but I believe the real savings is somewhat intangible. Since our incinerator was completed in 1984 there have been a number of changes in the rules and interpretation of existing legislation, by EPA to the point that we would find it very difficult and expensive to pursue other methods of disposal.

The changes I refer to include changes by the Nuclear Regulatory Agency which has resulted in our decision to stop all burning of any radioactive materials. This includes the declassified materials as well. If we decide to reconsider this issue in the future we will need to conduct a campus wide analysis of our stack discharge plume to make certain we fall within the discharge limits.

In an effort to comply with the EPA regulations on incineration of hazardous wastes we have been able to develop a process which has been approved by the State of Nebraska Department of Environmental Control which represents the EPA in Nebraska. Every two weeks the incinerator is cleaned of all ash. The flammable hazardous wastes which have accumulated in that two week period are then batch fed into the incinerator. When all of the material has been consumed the remaining ash is removed and sampled. Once this takes place the ash is taken to a local land fill and treated as hazardous waste. We are then able to proceed with our normal incineration routine.

Our normal burning routine begins with the specially designed, movable bottom trailers which are located at strategic spots around campus. These are filled by custodial service employees as they clean the various buildings on campus. The trailers are pulled to the incinerator site on a daily schedule where they are emptied into the charging hopper. The 18 yard trailers, when filled, can be emptied in approximately 1 hour and are then hauled to the next site. This arrangement allows us to get by with only one extra trailer. We normally burn 11 hours per day for 5 days, then 4 hours the other 2 days each week.

The current cost of incineration, including all fuel, labor, repairs and land fill costs is approximately $57.00 per ton. We expect this figure to escalate substantially in the future as stack discharge standards become more restrictive, the definition of infectious wastes is developed, a manifest system is developed and our equipment ages.

In discussing these issues with others who are faced with similar disposal problems and EPA officials it is apparent that regulations are gravitating toward a more restrictive environment with substantially higher fines for non-compliance. Currently there is a study underway, which is the result of the Luken Bill, involving New York, New Jersey, Connecticut and the States contiguous to the Great Lakes. This legislation is scheduled to last 24 months and involves primarily medical wastes. The effects of this study however, will effect all of us because it may well set the standards for disposal of all wastes which are classified a greater hazard than the general office and cafeteria wastes. Perhaps one of the ironies of this whole waste management issue can be found in the fact that household trash as a whole is more infectious and potentially more hazardous than waste from other sources. The problem here is that very few will believe you and it doesn't have the appeal that larger single generators have.

In summary the problem to a large extent is political, since states, countries and cities have not been willing to produce controlling legislation which will regulate waste pollution. Consequently the Federal Government i.e. EPA has come into being and legislation is being enacted in an effort to control pollution. Perhaps one of the biggest problems we have today is in defining the various types of wastes. Technology today can handle destruction or change-of-state of almost any material. If we can get a good definition of what constitutes a particular waste stream then we can prescribe a destructive process. This problem is more evident if you take the case of a hospital. If current definitions say that any material coming out of the institution is non-acceptable waste including the products of combustion, the flue particulate, and ash then the only option left is to classify each waste stream, separate them at their source and handle them individually.

The general consensus today is to see which states have the most restrictive regulations and pattern your program to meet those standards. If we develop our strategies to meet regulations which are still in the formative stages, then our institutions will be in a better position to develop an infrastructure that can support changes with out causing bankruptcy.

Managing at the Small College: Being Greater With Fewer

Charles W. Jenkin, P.E.
Director of Physical Plant
St. Mary's University

Introduction

"THE PHYSICAL PLANT DEPARTMENT MUST LEARN TO DO MORE WITH LESS." Don't you wish you had a dollar for every time you'd heard someone say that? I could buy a steak dinner just from keynote addresses at APPA meetings. I always get a little rankled, too, because to me that admonition presupposes that there are waste and inefficiency in my operation that I haven't already and don't continually try to streamline out. What the people who use that phrase mean to convey, I trust, is that we should seek every opportunity to stretch our resources.

A phrase I <u>don't</u> find offensive is "working smarter - not harder." We can all do that and I believe that we who manage in the small college environment have the most compelling need, and the greatest opportunity, to do so. Our challenges are exactly the same as those at the mega-campuses, but on a smaller scale. We don't have large staffs and multi-million dollar budgets, but that very fact affords us an opportunity to be innovative and flexible where larger, more cumbersome organizations might not be able to. We have less money and fewer people, but, by bold experimentation and a willingness to test innovative ideas we can be greater - with fewer.

On the pages to follow I'll relate some of the ways we go about our business at St. Mary's University; ways that we believe have stretched our resources. Some of the things we do have been rejected by others, I'm told, as too difficult or too complicated to work at a small college. Yet, we've had good luck

with them. Before we get to that, however, let me digress to tell you a little about our university, our campus and our physical plant staff.

St. Mary's is a private university operated by the Catholic Church's Society of Mary. About 3500 students study liberal arts, the natural sciences, engineering and business, among other courses, on our 135 acre campus. We also have a law school and just this year opened our first doctoral program. It is now possible to earn a St. Mary's Ph.D. in Counselling while attending class only in San Antonio. That's a first for our city. Our 32 buildings comprise about 910,000 sq. ft. of occupied space. Our oldest facility was built in 1896, our newest in 1987. We're San Antonio's oldest institution of higher learning.

Our Physical Plant staff of 64 is organized as you see in Fig. 1. The activities which occupy our people are pretty much as you'd expect. The Administrative Staff are the Secretary and a Work Control Clerk.

The Central Plant Operations Division of nine people operates and maintains our central cooling and heating plant which serves all but six of our buildings. They also maintain all HVAC equipment in the buildings, the distribution loops, the computerized energy management system and the campus electrical net. We have a vigorous Preventive Maintenance program in this area. All asbestos inspection and some abatement activities are done by this group.

The Building Maintenance staff is comprised of craft and tradesmen. They maintain all structural components and plumbing systems. Our lone electrician reports to the Central Plant Superintendent but works at least half the time for the Building Maintenance Superintendent. I'll say more later about this group.

We have seven groundskeepers and I'll say more about them later also. Our auto mechanic keeps up the physical plant fleet of general and special purpose vehicles, including golf carts. The automotive helper is on the staff primarily to service the fleet of seven automobiles driven by the members of our religious community.

Our housekeepers work in two shifts. The day shift works in residence halls where we service only the community areas - no student rooms. The night shift cleans offices, classrooms and laboratories.

With that introduction, then, let's get on to some of the things we do in our attempt to be greater with fewer. Let's talk about getting organized.

Organize Your Customers

Organizing has been defined, in part, as "the function of creating the structure of working relationships...".[1] Certainly, the structure of the working relationship between us and our customers should be defined, for both our sakes. Do you have a services guide for your department? A services guide is not only good public relations, but it establishes the rules by which everyone's supposed to play when obtaining physical plant services.

One very important function of this guide is to define who pays for what. I can't imagine a more chaotic or unfair situation than one in which the Physical Plant Director is expected to budget for and cheerfully provide any and all facility support actions and services which the university community may ask for during the budget period. He or she is expected to somehow anticipate the renovations, alterations and equipment installations which may come up in the various departments. That seems to me a no-win situation, yet I'm told of places which operate that way.

A much more equitable arrangement, in my judgement, is to designate all those actions required to maintain and operate existing facilities as "plant" services and fund the Physical Plant Department to provide them without charge to the community. Renovations, alterations and additions necessitated by changes in the teaching or student support missions are then called "departmental" services and are paid for by the department with the need. This places the responsibility for planning ahead with the manager who should be doing it. It also assures that there are no hidden costs associated with new course offerings or improved service to students.

So, if your services guide does nothing more than define physical plant and departmental services, it's worth having. It can also go much further in clarifying the structure of your working relationship with customers by explaining how to request services, how quickly a response can be expected, what to do in an emergency and a myriad of similar things your community should know. Making this information readily available to them will make you look more professional in their eyes. A services guide, no matter how humble, can do that for you.

Speaking of requesting services, how do your customers make their needs known to you? I was visiting a fellow plant director several years ago when a call came in reporting an inoperative air conditioner. He tore a piece of paper tape from his adding machine, scribbled the room number on it, and stuck it in his shirt pocket. At a later time, I suppose, he retrieved the note and sent someone to check out the problem. That was the extent of his service request system, or at least that's what he told me.

Your customers will appreciate you and you'll be more efficient if you have an established procedure for requesting physical plant help. At St. Mary's we use a small 3" X 5" form, supplied to our customers in pads of 50. (See Fig. 2). We accept telephone requests, of course, but still encourage the community to request routine things with the form. By the way, we require that requests for departmental services be made in writing and that the request specify the budget to be charged. That way, there's no misunderstanding about who's footing the bill for the work.

The last thing I'll mention as regards organizing your customers is feedback. Your customers will really appreciate you if you act interested in their appraisal of your service. Some places use questionnaires or similar documented forms of feedback. At St. Mary's we have no formal system. Instead, we make it a point to talk with, and listen to, our customers. My four superintendents and I regularly check the pulse of the community and respond quickly to put out any brush fires that may be flaring up. We think that's why, when we do get letters, the compliments outweigh the hate mail by a sizeable margin.

Organize Your Work

In the plant maintenance business, we can categorize our workload into different segments. We all deal, first and foremost, with the day-to-day operations and maintenance of the campus. In this category of work are such things as running the boilers and chillers, landscaping the grounds, janitorial services and answering customer trouble calls. We are afforded a certain staffing level and monetary budget for these tasks.

Hopefully, we also engage in certain preventive maintenance tasks, also called periodic or scheduled maintenance. This is another segment of our workload. It requires resources in addition to normal O&M, but the cost is more than offset, we argue, by fewer service interruptions and longer equipment life.

Let's talk for a minute about organizing these two kinds of tasks into manageable chunks, getting them to the doers and making sure they get done in a reasonably timely and efficient fashion.

Recurring everyday tasks like groundskeeping and housekeeping can be done with a set daily or weekly schedule. There's very little hour-by-hour direction necessary nor is detailed accounting required for the time spent doing these sorts of tasks. Managing the myriad small tasks that have a definite start and finish, and which each craftsman may do a dozen or so of in a day , is a different matter. To manage these jobs well I'm convinced that you need a computer. At St. Mary's we've computerized both our work order system and our preventive maintenance schedule.

Remember the service request we talked about earlier? On an average day we'll get 20-25 of them from our customers and from our own housekeepers and maintenance men who've noted a problem. Using the numbered request form as a source document, our work control clerk creates a computerized record of the request, identifying it by number. She then tells the computer to print a work order bearing the same number.(See Fig. 3). The work order goes in two copies to the shop and is assigned to a craftsman who takes care of the problem. Before he leaves the work site he gives the second copy of the work order to the requester who then knows the call has been answered. He records his labor time and the cost of the parts he used on the bottom of the original form, as well as the date he finished the job, and turns it in. His supervisor reviews the document and, when everything meets with his approval, returns it to the work order clerk. She calls up the record from computer memory and updates it with the information provided by the craftsman. This completes the automated record for a single work order.

Here's how we use those records to organize our work. First, every record has a date of request and date of completion. When a record is first created a special code is placed in the space reserved for completion date. By sorting out of the file all records representing requests over two weeks old which still have the special code in the completion date space, the computer can identify to us open work orders which have been in the system over two weeks. Once a week my superintendents and I review that list and highlight any problem work orders for special attention. This report sure keeps things from falling through "the crack".

At the end of each month the computer produces a report which lists all the work orders completed that month, sorted by customer. We use that report for billing. The computer sorts the same bunch of work orders by shop and we can see how productive each shop was for the month. We can do the same analysis by individual craftsman. You can build such a data file as this on any microcomputer using off-the-shelf database management software.[2] You can also buy canned work order systems to operate on the same computer if you prefer. I knew virtually nothing about computers six years ago and our department had none. Now we have two terminals to the university's main computer, a PC for word processing (this paper is an example) and another in the Central Plant. These are in addition to the computer which runs our energy management system. I don't know how we could do without them. They definitely help you to work smarter.

We also have our PM system of about 900 recurring tasks in the computer. In less than two minutes the computer will search the file and identify the tasks to be done in a particular month. In another 20-30 seconds it dumps the list into the work order system for tracking. In another two minutes it prints the work orders for issue to the appropriate shops. (See Fig. 4). At the

end of the month it updates the maintenance history of all the tasks which got completed. That takes two more minutes. I can't be too emphatic when I advocate a preventive maintenance program. Whether you use a computer, rolladex file or 3X5 cards to monitor your PM program, it's a lot smarter way of doing business than ignoring the equipment until a breakdown forces you to service it.

So far we've mentioned only maintenance and repair. Still another category of work is facility alteration, renovation or new construction. At St. Mary's we stoutly argue that our normal staffing and annual O&M budget are predicated on our doing only operations, maintenance and repair. Any other class of work must be funded from areas outside the physical plant unless, of course, it's work done for the physical plant department's benefit. Then, I must anticipate the requirement and budget for it just as do the university's other managers. Once such a requirement is funded, though, I must decide how to get it done. If it isn't too large in scope, I'll probably rob the time from normal maintenance activities or do it on overtime. Maybe I'll put overhires on the staff just for the duration of the project. Most likely, however, I'll elect to contract for the work.

When contracting for renovation work, even to scopes of work involving six figures, we've had good luck using a technique I call the "poor man's A-E" approach.[3] I tried it once out of necessity. It worked, and now my Central Plant Supervisor uses it and so have the Residence Life people. We just make single line scale drawings of the space to be renovated, then put notes on the drawings where changes are to be made. (See Fig. 5). We use one sheet for demolition, another for structural changes, another for electrical, etc. Then we put some simple standard bidding instructions and contract conditions on top of the drawings to complete a bid package. We contact three or four reputable contractors in the area and invite them to a pre-bid meeting. When they come we give each a copy of the bid package, walk the area to be renovated and answer any questions. All bidders hear both question and answer. Once they bid and we award the contract we do our own construction management from start to finish. We've avoided thousands of dollars in A-E fees over the past six years by using this scheme and I can't tell that we've sacrificed anything in return. 'Mind you now, I'm only advocating this technique for simple renovations. Big construction jobs or entire building overhauls we, of course, hire a pro to design and oversee for us.

What about things we don't get around to doing either in-house or by contract? They become a part of the "ticking time bomb" - our deferred maintenance backlog.[4] Friends, I'm here to tell you that you needn't let that monster scare you. If you'll systematically identify and categorize your deferred maintenance projects you'll find them much less frightening, simply because they've become known quantities. About six years ago, we had no

coordinated approach for dealing with the deferred maintenance backlog. We had no coordinated approach for dealing with a stopped up toilet either, but that's another story. I was directed by my boss, the Vice-President for Financial Administration, to develop and execute a five year plan for completing deferred maintenance requirements. Before we could complete them we had to identify them. So, for about a year my staff and I, using consultant expertise when necessary, surveyed the campus, noting and listing maintenance projects. Each project was named, defined as to scope and assigned an estimated cost. Then, we published the list in the format of Fig. 6.

I was told to budget $100,000 per year for deferred maintenance and the same amount for preventive maintenance. Oh yes, there is also a five year listing for PM projects and, for that matter, one for renovation and alteration. These budget allocations were over and above my normal O&M budget. Our list included about $1.5 million in deferred maintenance projects, so budgeting $100,000 per year for five years wouldn't nearly cover it all. We just put what we considered the most critical requirements at the top of the list and left the rest in the sixth and subsequent year balloon.

We update this plan once a year and send it through channels to the Executive Council. I invite them to rearrange priorities as they see fit. They've never done so. None of these plans, by the way, include residence hall requirements. Our Residence Life people budget their own money toward their own plan, but with considerable input from us which they've solicited and we're happy to give.

We rocked along for three years or so spending 2-3 hundred thousand per annum on DM and PM. The place wasn't deteriorating, but neither was it getting better as fast as I'd have liked. About this time our associate John Heinz got a lot of publicity in physical plant circles by making a video tape of DM requirements and playing it for his legislators in the state of Washington.[5] I figured I could copy a good idea as well as anyone, so, with the approval and encouragement of my boss, I prepared a 35mm slide presentation of DM on our campus. In December 1986 I gave the show to our Executive Council, who have the same clout at our little private school as do state legislators. The results were dramatic. From an outlay of $110,000 for deferred maintenance in 1986-87, we went to $608,000 in 1987-88 and $576,000 in 1988-89. I'm now instructed to budget $300,000 per year for deferred maintenance projects. We also have the plant contingencies fund which is another operating budget line item amounting to $150,000 per year. It is to provide a safety net against catastrophic and unexpected failure of a critical component such as a chiller. If we have no such contingency, I spend the money on preventive maintenance projects at year end. There's still a sixth year and beyond balloon in our plan, but there will always be that, and ours no longer concerns us. Through a logical, organized approach we've met the enemy and

with continued diligent effort can make him ours. Any of you can do the same. Organizing your work and attacking it with a plan is, we think, working smarter.

Organize Your Workforce

With your customers and workload organized, it's a good idea to organize your workforce in a manner most able to deal with the organized workload generated by the organized customers. Our organizational chart is plain vanilla as Fig. 1 shows. There's nothing innovative about the lines of authority or groupings of skills. Within those various groupings, though, we try to be imaginative in the way we assign work. Given the choice between a task generalist - one who stays in a small geographic area doing many different things, and a task specialist - one who goes all over the campus doing only a few selected things, we tend to generalists.

Our groundskeepers are each assigned a specific area of the campus to maintain. In his area, the assigned groundsman polices, mows, edges, trims, prunes, fertilizes and all the other normal maintenance tasks. For more involved endeavors, e.g., extensive tree surgery, pavement repairs, sprinkler repairs, a crew will be formed from among the grounds staff for the duration of that project. This staff, by the way, is supplemented with overhires during the summer when we restripe traffic lanes, paint curbs, etc. The geographic assignment of tasks has distinct advantages, one of the most prominent being that it inherently capitalizes on the American competitive spirit. Our groundsmen naturally compete with each other to see whose area is kept the prettiest. We abet that competition by selecting an outstanding area each month and applauding the responsible party. Another advantage is that our customers become accustomed to seeing the same groundskeeper on a regular basis. They tend to identify with him and are comfortable with his presence. This is especially true in the student residence areas.

Some time ago we asked our Admissions people to include on the rating questionnaire they give to visiting prospective students and parents a score for the appearance of campus grounds and buildings. On a scale of 1-poor to 5-excellent the ratings have consistently been 4.8 to 4.9. We've even seen a few individual scores of 5+. Having been told that an attractive physical plant, more than any other single factor, convinces high school graduates to choose one college over another,[6] we think our grounds staff are doing their part in recruiting.

What's that? You say that assigning areas to groundskeepers isn't innovative? Probably not, but we do the same thing with our building maintenance staff. Our craftsmen, as Fig. 1 suggests, are considered maintenance mechanics (generalists) first and carpenter, plumber or locksmith (specialists) second. Each of those six mechanics has several buildings assigned solely to him. He may not have one-sixth of the buildings but he has one-sixth

of the workload, as nearly as we can divide it. The responsible mechanic answers all trouble calls in the buildings assigned to him, calling for help from another mechanic or a specialist only when necessary. In addition to trouble call work orders, each month each mechanic gets a work order for each of his buildings, produced by our computerized PM system, instructing him to inspect the building and replace bad lights, lubricate hinges and locks, repair dripping faucets, etc. The purpose of this is to find and fix things before an occupant tells us about it. The PM system also tells him to periodically inspect the roof, operational check sump pumps, service water heaters, etc. The mechanics identify with their buildings and take pride in keeping them functional. Each develops a corporate memory of the state of maintenance of his buildings. The occupants in his buildings identify with him and call in asking for him by name. Here again our physical plant staffers become real live people to the community, as opposed to faceless automatons. We think this approach is a bit imaginative.

The generalist rationale extends to our HVAC maintenance effort as well. Our technicians are assigned specific buildings and systems. They perform all PM tasks in their assigned areas, which occupies about 70% of their time. They also are the first to respond to trouble calls in a building assigned to them. So, the familiarity between customer and service provider is present in this operation, also. We've found an additional payback here. Because of the continuity of effort, our technicians are quick to recognize individual occupants who have uncommonly sensitive body thermostats. It only takes a couple of calls for us to identify people who are too warm or too cool when everyone else in the building is comfortable. We save a lot of effort by virtue of having this knowledge.

Regardless of your staffing level, you might find this generalist idea useful when organizing your staff to deal with the workload.

Convincing Others That You're Greater

So, after years of diligent effort you now have your operation running like a well-oiled machine. Does anyone outside your department know it? There are some subtle ways to call your excellence to their attention. I earlier mentioned a computerized customer billing report. We send a copy of that report every month to each Vice-President, Dean or Director who heads a customer area. If the customer reimburses us, as does an auxiliary enterprize, for example, then they have a record of what their money was spent for. If they don't reimburse, we've still called to their attention the fact that university resources were expended in their behalf by the Physical Plant Department. In its small way, the report keeps us from being out of sight and mind.

I also send to the Executive Council members a yearly

reminder in the form of an annual report. In this report the astute executive can find data which tells him or her exactly how many work orders representing how many dollars were done for his departments during the year. He can also see how his area fared versus each of the others when the facilities services pie was sliced. The report tells them about our year's experience with purchased utilities, an area which demands almost 7% of the university's operating budget. We enumerate the major facility projects completed during the year and their cost, individually and collectively. We also point out the things done within the department by way of staff professional development, improved procedures and new or improved services. We mention any honors earned by the department or its members. This report reminds our executives that plant operation and maintenance is big business and that it's in the hands of competent professionals. It also boosts my ego to write it. I recommend the experience to everyone.

One final thing we do at St. Mary's is to host an annual open house for the university community and the families of our staff members. On this afternoon we stop work two hours early and open the shops and offices to visitors. Our staffers create displays and demonstrations to show our customers, as well as Mom and the kids, just what it is they do all day. As visitors from outside the department oh and ah over things they never before knew existed, the chins of the demonstrators lift and chests expand. The tour ends with refreshments in one of the shops. This yearly function acquaints all our customers, from grass roots to executive suite, with the myriad services provided by the Physical Plant Department and with the individual people who provide them. An added reward is that once a year our storage areas are cleaned out, the work areas and equipment are immaculate and every staff member sports a spanking clean uniform, fresh haircut and shoeshine.

All these things are reasonably easy, inexpensive image improvers. They've been well received at St. Mary's.

Convincing Yourself That You're Greater

Convincing your customers that you're great is certainly worthwhile, but it's not enough. The people in your department must also believe that they're great - and now we're talking about motivation. At St. Mary's those of us who supervise try to do all the standard things which the experts tell us improve employee satisfaction, like assigning meaningful tasks, affording adequate training, furnishing appropriate supplies and equipment and offering encouragement. We also let them know we care about them by insisting on safe work habits, providing protective equipment and promptly removing hazards.

Then we go still another step by recognizing them as individuals. Every new employee is afforded a systematic

orientation to the department which includes a 25 minute slide briefing by me. Regardless of the excellence or mediocrity of his or her contribution to the work effort, every staff member gets a letter from me on the anniversary of employment with the university. The letter acknowledges the number of years of completed service and thanks them for their dedication. I add a handwritten postscript to every letter, making a personal comment to the recipient. On the third Monday of each month we gather for a departmental meeting. Unless we show a safety film, it's over in about 15 minutes. We start by singing Happy Birthday to everyone with a birthday that month, each of them having been named before we sing. We name everyone with an employment anniversary (the letter recipients) and applaud them. Then we name everyone who had perfect attendance during the previous month and applaud them. At the January meeting we give an engraved plaque to everyone who had a record of perfect attendance for the previous year. Moving on, we present a congratulatory letter from the University President to the previous month's Craftsman and Housekeeper of the Month (two awards). These honorees are selected by supervisory ballot. Besides the letter, a picture of each individual is placed in a special plaque in the department office until the next month. Finally, we name a person or group as Champion of the Month for the previous month. I'm the sole selector for that award and I can give it to anyone, in or out of the department, whom I believe did something of championship quality toward improving our image. The champion's name or names go on a different plaque in the front office.

Once a year, at the December meeting, we present three awards in addition to the monthly ones. We give a wall plaque and a $100 bonus check to a Craftsperson of the Year, a Housekeeper of the Year and a Supervisor of the Year. The non-supervisors are selected by a panel of judges based upon nominating speeches presented by their supervisors. The supervisor is selected based upon nominating letters written by the supervised personnel. Beside the individual awards, the names of the annual honorees go up on yet another plaque in the front office. There's a lot of excitement around our place every December as we wonder who's going to get that extra Christmas shopping money.

Some will say that plaques, certificates and rah-rah meetings are hokey. "Not so", say we. Our people thrive on the recognition and have come to expect it - when deserved. We tell them regularly that they're great. Just as regularly, they show us we're right.

One final thing we do to keep our people feeling good about themselves is to send them to training seminars and assist them with self-improvement courses which are job applicable. Through an agreement with our local Honeywell office, we provide classroom space and breaktime refreshments for their factory courses in San Antonio. In return we get one or two free seats for the course, which we fill with the posteriors of our HVAC

repairmen. Our groundskeepers regularly attend courses offered by the Texas Turfgrass Association and local nurseries; our housekeepers and maintenance men those offered by equipment and supply vendors. We frequently have craftsmen in local trade schools taking evening courses in plumbing and refrigeration maintenance. If they bring us a tuition fee slip and a passing grade report we reimburse them from departmental funds. This year, for the first time, we sent our Supervisor of the Year to the APPA Institute. He attended the one in Austin in January. Last year we started an on-campus course for our people to study for the GED examinations, partly on our time, partly on theirs. So far, we've had two people successfully pass the exam.

Closing

This composition has addressed a lot of topics in a short time. Hopefully, it isn't too fragmented or discontinuous. We've mentioned numerous examples to support the premise that by organizing your customers, your workload and your workforce, you can work smarter and be greater. The thrust I hope to leave with you is, as the introduction suggests, that the things we hear and read about as state-of -the- art management techniques need not be discounted solely because we're small colleges. They can work and are working at numerous institutions. St. Mary's is just one of them.

PHYSICAL PLANT ORGANIZATION
Figure 1

ST MARY'S UNIVERSITY
PHYSICAL PLANT SERVICE REQUEST

Building: Treadaway Room: Seminar A

Required Service: Please prepare room for Alumni Assn. meeting. Check lights. Need A/C from 3 - 5 pm. Set up 4 tables in horseshoe. 6 chairs per table.

Requestor's Name: M. Etlinger Meeting date is 2-27-89.

Requestor's Office Location: A209

Requestor's Extension No.: 3324

Date of Request: 2-22-89

№ 32313

SERVICE REQUEST
Figure 2

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ST.MARY'S UNIVERSITY
PHYSICAL PLANT DEPARTMENT
MAINTENANCE WORK ORDER

WORK ORDER: 32313 DATE OF REQUEST:89/02/22

SHOP:HSKPG LOCATION:TREAD

REQUESTER:ETLINGER EXT.NO:3324

WORK REQUESTED:
SET UP FOUR TABLES IN A HORSESHOE,
6 CHAIRS PER TABLE. CHECK LIGHTS,
NOTIFY MAINTENANCE IF ANY ARE BURNED
OUT. MEETING IS 2-27-89, 3-5 PM.
DATE COMPLETED: COMPLETED BY:

MAN-HOURS USED:

MATERIALS USED AND COST:

MAINTENANCE WORK ORDER
Figure 3

ST. MARY'S UNIVERSITY AUG 1989
PHYSICAL PLANT DEPARTMENT
PREVENTIVE MAINTENANCE WORK ORDER

KEY: ADMIN00306

EQUIPMENT DESCRIPTION: Five AHUs, 3N,3S,Bursars

LOCATION: ADMIN

TASK DESCRIPTION:
Clean drip pans, check belt and alignment,insulate
pipes,inspect coils,flush condensate lines, use
pantabs,clean petcocks,replace bad nipples,clean
electric motors,clean air handler unit.

TOOLS AND TIME:
4 ea. pantabs (cost $1.00);10.0 hrs.

DATE COMPLETED: _____COMPLETED BY:_____

MAN-HOURS USED:_____

MATERIALS USED AND COST: _____

PREVENTIVE MAINTENANCE WORK ORDER
Figure 4

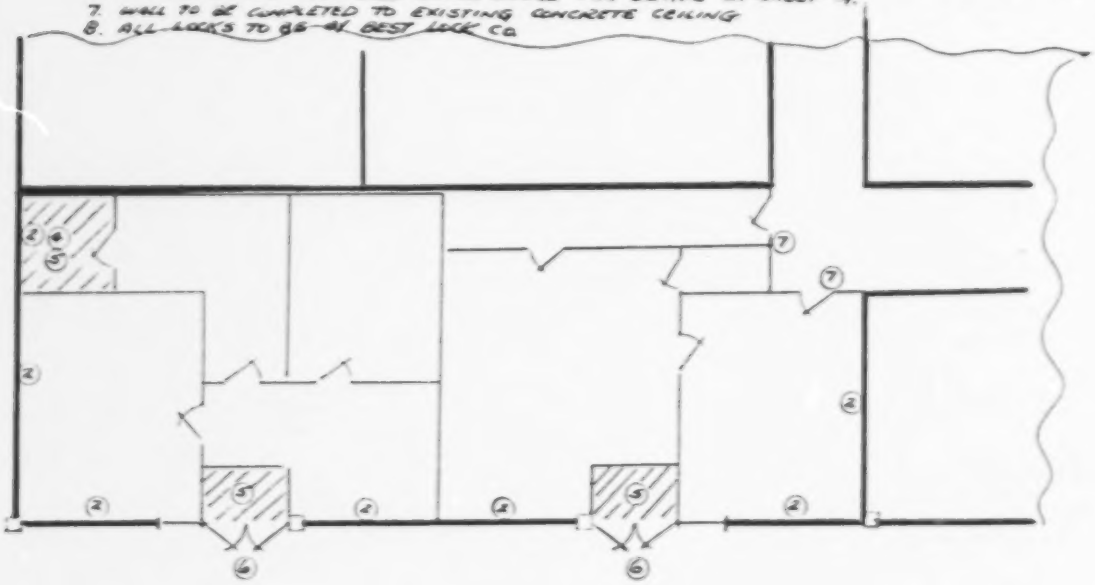
ST. MARY'S UNIVERSITY

CONSTRUCT OFFICES IN GARAGE AREA OF TREADAWAY HALL

SHEET 1 of 7 : DEMOLITION PLAN
2 : CEILING PLAN
3 : CONSTRUCTION PLAN
4 : EXTERIOR DOOR DETAIL
5 : MECHANICAL PLAN
6 : LIGHTING PLAN
7 : ELECTRICAL POWER PLAN

CONSTRUCTION PLAN SCALE: $\frac{1}{8}$" = 1'0"

NOTES: 1. HEAVY LINES INDICATE EXISTING CMU WALL LIGHT LINES INDICATE NEW WALLS OF UNISTRUT COLORLINE 375 MOVABLE PARTITION, OR EQUAL.
2. WALLS TO BE COVERED WITH "FLEXI-WALL PLASTER IN A ROLL" OR EQUAL.
3. SUSPENDED T-BAR 2'X4' LAY-IN CEILING THROUGHOUT ENTIRE AREA, 8'6" FROM FLOOR.
4. LAV, WC, CLG. EXH/HTR. TO BE INSTALLED HERE. ½" CW, ½" HW, 3" WASTE EXISTING.
5. HATCHED AREAS TO BE COVERED WITH VAT OR SHEET VINYL, REMAINDER CARPETED BY OTHERS.
6. INSTALL OWNER FURNISHED GLASS DOORS PER DETAIL ON SHEET 4.
7. WALL TO BE COMPLETED TO EXISTING CONCRETE CEILING
8. ALL LOCKS TO BE BY BEST LOCK Co.



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SIMPLIFIED PLAN AND SPECIFICATION
Figure 5

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ST MARY'S UNIVERSITY

April 5, 1988

TO: Vice President, Financial Administration

FROM: Director, Physical Plant

RE: Five Year Maintenance Plan

Attached is the annual update of our five-year plan.

Categories of work and estimated costs are:

Budget Year	Deferred Maintenance ($X1000)	Preventive Maintenance ($X1000)	Renovation ($X1000)	Total All Classes ($X1000)
1988-89	312	100	1	413
1989-90	325	118	-	443
1990-91	200	75	-	275
1991-92	200	112	-	312
1992-93	200	70	-	270
1993-out	1979.5	846.5	618	3444

The total estimated cost for all classes of work in the plan is $5,157,000.

Please advise if you want others to receive copies of the plan.

I believe an update of the slide presentation I made to the Executive Council in December 1986 would be beneficial. If you concur, please arrange an agenda date and I'll prepare the briefing. I await your direction regarding these two items.

Attch: Five Year Maintenance Plan, April 1988

CWJ/kjn

PHYSICAL PLANT
ONE CAMINO SANTA MARIA
SAN ANTONIO, TEXAS 78284-0300
(512) 436-3335

FIVE YEAR DEFERRED MAINTENANCE PLAN
Figure 6

ST. MARY'S UNIVERSITY

DEFERRED MAINTENANCE PROJECTS

APRIL 1988

Proposed Budget Year	Project Title	Description of Work *denotes energy conservation project	Estimated Cost
1988-89	Overlay streets and parking lots	Remove failed areas of pavement, rebuild base course, replace removed pavement to existing grade. Apply 1" new asphaltic concrete over entire road surface. Scope of work includes street from Culebra St. entrance to V.J. Keefe Field.	$ 112,000
	Replace roofs, Administration Bldg., and Reinbolt Hall	*Remove and dispose of composition shingle roofs, replace with standing seam metal roofs.	$200,000
1989-90	Replace PCB Equipment	Replace PCB electrical transformers and capacitors with non-PCB equipment, OR downgrade to non-PCB status by retrofill.	$ 70,000
	Replace roof Alumni Gym	*Replace deteriorated composition shingle roof with single-ply rubber continuous membrane.	$ 80,000
	Replace starter, Chiller No. 2	Replace Star-Delta electric starting system for chiller No. 2 in Central Plant with an auto-transformer system.	$ 25,000
	Overlay streets and parking lots	Remove failed areas of pavement, rebuild base course, replace removed pavement to existing grade, apply 1" new asphaltic concrete over entire road surface. Scope of work includes street from Treadaway to Academic Library and Faculty Residence, parking lots L and M.	$ 25,000
	Improve surface drainage, Treadaway Hall	Regrade terrain around Treadaway Hall outside perimeter to correct drainage problems. Add landscaping where required to improve appearance and/or replace plants lost in grading project.	$125,000

NOTES

1. Thomas O. Kirkpatrick, "Supervision", Kent Publishing Co. 1987, p. 129.

2. Charles W. Jenkins, "An Automated Work Order System for the Small University", Proceedings of the 71st Annual Meeting of APPA, 1984, pp. 16-28.

3. Charles W. Jenkins, "Building Renovations Using Simplified Plans and Specifications", Central States Regional Association Newsletter, Issue 34, March 1986, pp. 7-9.

4. Sean C. Rush and Sandra L. Johnson of Coopers and Lybrand, "The Decaying American Campus, A Ticking Time Bomb", APPA, 1989.

5. John A. Heinz, "Marketing the Physical Plant" , Proceedings of the 73rd Annual Meeting of APPA, 1986, pp. 122-130.

6. "Schools' Looks Draw Students", APPA Newsletter, Vol. XXXIV, No. 11, November 1986, p. 1.

An Asbestos Abatement Project: Learning the Hard Way

Ken C. Fay, C.R.S.P.
Manager, Safety Office
University of Calgary

Good afternoon, I would like to do some reminiscing on my experiences with asbestos. My first recollection of asbestos is 1955, my last year of high school, where the use of asbestos gauze pads in chemistry labs and asbestos brake linings in the automotive shops was commonplace. Upon leaving high school, I worked for an electric and gas utility company which constructed two thermal generating stations. Asbestos containing insulating materials were used throughout these plants. At the atomic research site where I was employed in 1965, asbestos insulation materials were used extensively in the construction of the nuclear reactor.

In the late sixties, I built an electric train layout for my two young boys. While constructing the scenery, I placed screen mesh over wood supports and then applied asbestos and plaster of paris mixed with water. I bought the asbestos at a hobby shop where the clerk opened a bin and scooped out dry asbestos into a paper bag. In 1969 we moved to Calgary and I started working at The University of Calgary. Of course, the children's train set came with us.

Concerns for asbestos related health problems began to surface about the mid 1970s. The University of Calgary Physical Plant had identified the more prominent sprayed areas on campus as probably containing asbestos. Two major areas of concern were the Library Block and the Engineering building, specifically the Energy Transfer Laboratory. The Physical Plant pondered what would be the best method of dealing with this up and coming problem. Removal would be very costly and finances were not available to undertake such a massive project. In April of 1975, the Safety Office carried out bulk sampling of areas that might

contain asbestos in the Library Block and samples were sent to the Alberta Occupational Health and Safety laboratory for identification.

On April 10, 1977, I telephoned Mr. Victor Osborne, Safety Manager at Yale University. The University of Yale had successfully completed an asbestos removal project. I discussed removal methodology with him and asked for any suggestions that would be of value in our upcoming program. Yale was one of the first institutions to undertake an asbestos abatement program. That same month, we requested Alberta Occupational Health and Safety take air samples from the Library penthouse. Readings ranging from 0.1 to 0.3 fibers/cc of air resulted and it was recommended further tests be conducted.

In June of 1977, after discussions with Physical Plant personnel, it was agreed that the Maintenance Department should try several different materials to seal the asbestos containing insulation. Several test areas were marked off in the penthouse of the Library Block and the sealants applied. The tough part came when the Safety Office was asked to evaluate these encapsulants. After several brain storming sessions, the Safety Office had a galvanized metal box with an open top and short pieces of four inch metal ducting at either end constructed. The box was secured tightly against the treated insulation. One end of a flex duct was attached to an electric blower and the other to the test box. At the opposite end, we inserted a tube which allowed us to attach a pump and filter to sample air that had been forced over the insulation. Needless to say, this attempt gave us no valued information. Finally, it was agreed that encapsulation would, at best, only postpone our problem, not solve it. The final solution would be removal of all asbestos containing insulation where possible. Encapsulation would be undertaken only as a last resort.

During the latter part of August, 1978, The University of Calgary undertook its first asbestos removal project. This became necessary due to major renovations of a large open area where the removal process was not overly complicated. The area was isolated from the rest of the building by use of six millimetre poly sheeting. Employees were hired on a temporary basis to strip the area and were instructed by the Safety Office on asbestos hazards, respirator use, etc. They were supplied with disposable coveralls, respirators, rubber gloves, hard hats and other safety related material. A change area was constructed, and as there was no floor drain available, workers showered in a nearby washroom. The procedure upon entering was as follows: change from street clothes to disposable coveralls in washroom, proceed to change area and put on respirators and rubber boots, then move on to the work area. Upon exiting the contaminated area, workers removed their coveralls, turned them inside-out and placed them in a bag for disposal. Boots and mask were left in the change area. Workers then put on a clean pair of coveralls and proceeded to the washroom to shower before leaving.

The asbestos containing insulation was soaked using two and one-half gallon pump tank fire extinguishers. A wetting agent was added to this water.

The material was scraped off the ceiling and then shovelled wet into plastic bags. These bags were then washed down and transported to landfill for disposal. This project was conducted at a time when procedures for asbestos removal had not been fully developed. A garden hose was used to keep the floors damp and the asbestos wet. The removal area was not subjected to negative pressure nor was monitoring conducted on this project. The Alberta Occupational Health and Safety Division was informed by letter of all actions taken during this procedure. Appropriate department heads were advised by memorandum prior to commencement of work.

Our next involvement with asbestos took place in 1980-81. In order to prepare a submission for funding to the Provincial Government, two pilot projects were undertaken for asbestos insulation removal. The purpose was to establish a time frame, budget costs and an acceptable level of removal for the remaining areas containing asbestos insulation.

The first project, started in 1980, involved the Fees Office located on the main floor of the Library Block. The area, 6,512 square feet with an insulation removal area of 11,070 square feet, was vacant at time of removal. The method employed involved wetting, scraping and bagging the insulation. Monitoring was done by the University Safety Office with no asbestos fibers detected outside the work area. This method took 1,260 man hours to complete.

The second project, started in 1981, involved the mechanical penthouse located on top of our four story Library Block building. The floor area, 3,200 square feet and actual removal area was 5,540 square feet. It was one of the most difficult areas we would encounter and would give us a top line removal cost. Problems of accessibility were encountered as there was only one interior stairwell. Access was provided by hoisting men and equipment up the outside by use of a crane. The wash up and change areas were located on the roof of the building.

During removal the heating and air conditioning systems were operated at one hundred percent exhaust and fresh make up air. The insulation was mainly made up of twenty percent chrysotile with a few selected areas of amosite. The area to be removed was isolated by plastic sheeting taped securely in place. Immediately prior to removal, an area of four by eight feet was wetted by use of a hand spray. The solution was made up of fifty percent polyoxyethylene ester and fifty percent polyoxyethylene ether. After ten to fifteen minutes, the stripping began. The insulation was wetted again as it was scraped off. Where possible, the scraping was used in conjunction with a vacuum system.

This removal method employed the use of a vacuum truck. During removal operations the area was under negative pressure maintained by the vacuum system. The vacuum system consisted of a six inch hose, run from the truck up the outside of the building. The hose was then manifolded into smaller hand lines for use by the workers. The contractor's trucks

were licensed for asbestos removal by Alberta Environment. To evaluate removal levels, the removal area was divided into three zones. The first area was scraped, vacuumed and insulation material brushed from all crevices including where the Q decking rested on the support beam. The second area was the same as the first except the brushing was deleted where the Q decking rested on the support beam. The third method only involved scraping and vacuuming, was much faster and was acceptable to the Alberta Building Standards Branch.

Air monitoring was conducted by the University Safety Office during the entire operation. Monitoring was conducted in the work area, immediately outside the work area, throughout the building and at the vacuum exhaust on the truck. The highest reading obtained was 2.65 fibers/cc which was inside the work area. The truck vacuum exhaust was 0.98 fibers/cc. All occupied building areas showed no detectable asbestos fibers.

The entire project was regularly inspected by the Alberta Occupational Health and Safety Division. The project took ten days to complete and involved six hundred man hours. The cost of the vacuum method was $16.77 per square foot, while the wet method was $7.02 per square foot. The vacuum method was quicker, but more expensive. The main problem with the wet method was the chance of flooding the floor below. This actually occurred with a damage cost of $12,000.

The University's next step was to identify the areas that might have insulation containing asbestos. This was undertaken in 1981. The Maintenance Department was requested to survey and document any materials that could possibly contain asbestos. The information was given to the Safety Office which arranged to obtain bulk samples for analysis. Fifty millimetre, wide mouth jars were used to obtain the samples. On soft surfaces the mouth of a jar was pushed and twisted to penetrate the surface of the insulation. On hard surfaces, the material was scraped into the jars. The lids were placed on the jars and sealed with tape, identified and then wiped with a damp rag. The jars were sent to the Alberta Occupational Health and Safety laboratory for analysis.

The results of the survey identified many areas containing either amosite or chrysotile asbestos ranging from a low of five percent to a high of eighty percent. A proposal was prepared for Advanced Education and Manpower, giving estimated costs for removal of asbestos from the University. Funding for the asbestos removal project was received in late 1982. A Project Manager was appointed from Campus Development to have complete responsibility for asbestos removal. He in turn would have a field Project Coordinator, responsible for the on site removal liaison with the contractor, Safety Office personnel and other University departments.

The building selected was the four story Library Block which had been identified as having insulating material containing 40 percent chrysotile. Planning began in earnest, with the principle occupants of the spaces, in order to work out the logistics. The scope of the work not only included insulation removal, by the wet scraping method, but also upgrading of all floors. All removal areas were to be resprayed with a new fire proofing material. Before respraying, maintenance

upgrading was done to mechanical and electrical systems. The flooring was reinforced to take greater weights and redesigned ceiling and light fixtures were installed.

Preparation and Planning

In implementing this program, Campus Development worked closely with three departments occupying the space; the Bookstore located in the basement, the Registrar's Office on the main floor and the Library. Each department had specific requirements to be met. The earliest the Library could relocate a floor, without affecting the academic program, was the last week of April. They also had to be back in operation no later than August 15. The preferred time for the Registrar to move was during the last week in September. They were required to be back in operation by the third week in November. The key to establishing a schedule was to vacate a complete floor and use it as a transition floor. A fully serviced temporary pre-engineered metal building, with plywood floor on wood sleepers, was constructed next to the library complex. The Bookstore was moved from the basement to this structure. Other areas would progressively move into the basement while their floor was being worked on.

Based on meetings held with the departments, the following schedule was established:

- One week for moving out.
- Three weeks for asbestos and equipment removal.
- Three weeks for reconstruction.
- One week for moving back in.

Each floor had a total disruption time of eight weeks. The schedule was sent to each area for approval before the plan was implemented. The schedule was second, fourth, main stairwell, third, first, penthouse and finally, the basement. This sequence was at the request of the Library to assist them in their restacking program. The major problem was relocation of all the necessary services required for departments to carry on with their regular work procedures. The Library also required a temporary book checkout station in the basement in order to maintain security. Any equipment that could not be moved was sealed in plastic for protection. All of the moves required design work and furniture layout which was done by the Design Department in-house. Due to an overlapping schedule, there was a time when the basement was occupied by both the Registrar's Office from the main floor and Library from the third floor.

The following contracts were established:

1. Hazardous Work: This included isolation of floors, removal of ceilings, light fixtures, duct and pipe insulation, the removal of the asbestos insulation and the spraying of fireproofing material.
2. Moving: A coordinator was hired to liaise between occupants and the contractor. The Library provided staff to mark shelf locations and to supervise the reshelving of the books. A numbering system was devised so that the movers could identify the categories and sections of material; moving was done by use of the elevators. Special carts, to hold the books, were constructed to speed up the moving process.

3. New Ceiling: Suspended ceiling installation on all floors.
4. Supply and Erection of a Temporary Building: This was to house the Bookstore.
5. Lighting: Reinstallation of cleaned lighting fixtures along with structural, mechanical and electrical alterations.
6. Alterations Work: Separate contracts for each floor.
7. Air Handling: Reinstallation of air diffusers and duct modifications.
8. Drapery Cleaning: Contract by floor.
9. Carpets: Supplying and installation of new carpet.

The University Safety Office was responsible for monitoring occupied areas outside of the removal area. The Safety Office obtained a FAM-1 Fibrous Aerosol Monitor, designed for on the spot measurements of the airborne concentration of fiber-shaped particles with a length to diameter ratio exceeding about three. It is portable and fully self contained, has automatic and direct digital readout of the number concentration of airborne fibers. It continuously samples at a flow rate of two litres per minute and performs the detection and counting of airborne fibers. The instrument is also capable of accepting a standard 37 mm membrane filter cartridge which proved invaluable on many occasions for checking calibration or verification of instrument readings. Also purchased were six personnel/area air sampling pumps. A bubble tube for calibration of these pumps was constructed. The University Safety Office worked in close consultation with the Alberta Occupational Health and Safety Branch. Much of our early sample analysis was performed by their laboratory. Results of daily monitoring was made available as received to the University Project Manager.

The contractor for asbestos removal was to ensure he met all government safety regulations and conduct monitoring within the removal areas. The following were done on a force account basis:

1. Temporary services for telephones, power and computer terminals.
2. Maintenance upgrading - structural, mechanical and electrical.
3. Removal of emergency and exit lights.
4. Reinstallation of duct work.
5. Floor repair.
6. Redecorating existing walls.

All service shut-downs were done by the University Maintenance Department.

Prior to starting the asbestos removal, the University Safety Office carried out extensive sampling in the building to determine background asbestos levels. All of the samples were below the detection level for phase contrast microscopy work which was 20,000 fibers per filter.

In early 1983, tenders were let and contractors selected. In February, the University Grounds Department commenced removing trees and levelling the land for construction of the temporary building to house the Bookstore. This was followed by construction of the building. Information seminars were conducted by the Project Coordinator and Safety Office personnel. This was designed to provide building occupants with information on the project and to alleviate any of their concerns.

On May 5, the contractor moved into the Library Block. The Bookstore was moved into the temporary building. Modifications and services to the basement were provided to accept materials and occupants. Once a floor was vacated it was isolated from the rest of the building by use of plastic sheeting. The area was posted with appropriate warning signs and access restricted. Ceiling tiles were removed and disposed of as contaminated waste. The light fixtures were removed, cleaned and stored for later use. Ducts and diffusers were removed before the asbestos removal began. The insulation was wetted, scraped then bagged for disposal. Each bag was sealed, labelled, decontaminated, then placed in a waste container located outside the building for disposal to city landfill. A special waste disposal permit was obtained from the city for disposal of the asbestos.

After the insulation removal, the area was fogged with an adhesive designed to prevent any fibers left behind from becoming airborne. The Safety Office then ran both FAM and cassette filter samples. On receiving satisfactory results of the filter air samples, the Project Coordinator was advised and the contractor was given permission to remove his barriers. This procedure was repeated for all occupied floors. The project was completed in January of 1984. The work essentially remained on schedule except for a delay due to flooding of one floor. This asbestos removal project was successful.

In late 1983, tenders were let to complete the remaining five campus buildings which were identified as containing asbestos. The successful contractor was awarded the contracts for all the remaining buildings. Work commenced on November 21, 1983, and three of the scheduled buildings were completed prior to the contractor moving to the Engineering Complex. During this contractor's work on these buildings, the Safety Office identified some thirty-nine poor work and/or safety practices. Some of the items documented were: failure to advise the Safety Office prior to commencing insulation removal or request to inspect and test enclosures; contaminated equipment moved from site; containment barriers removed before inspections; no post removal monitoring and inadequate removal of insulation. Insulation was discovered on floors and equipment after projects were completed.

The asbestos abatement program for the Engineering Complex began April 9, 1984. After several smaller removal projects in the building, the contractor moved his equipment to the sub-basement of "C" and "D" Blocks. The mechanical rooms, the high temperature vault, the electrical vault, and the ceiling of the west stairwell were isolated by use of two layers of six millimetre poly. An exhaust fan with a HEPA filter was set up to maintain negative pressure of approximately 0.2 inches of water gauge. The exhaust from this unit was directed to the outside air. The entrance to the work area was via an outside hatch by metal stairs. The change area was constructed at the bottom of the stairs and subdivided into three parts. A clean change area, shower room and dirty change area. (See Figure 1).

An electrical maintenance shutdown had been previously scheduled by the Maintenance Department and this required access of tradesmen into the electrical vault for the weekend of June second and third. To accommodate this, it was necessary to construct an isolated tunnel into the electrical vault. Removal of 6,300 square feet of insulation began

on May 22, 1984. The mechanical area contained both supply and exhaust fans which serviced the Energy Transfer Lab, "C" Block and what we refer to as the Bridge Wing. Only the "D" Block had supply air as all exhaust was via the fumehood systems. Due to the time of year, it was decided to allow all fans to operate and to isolate these from the removal area. Along one wall were a number of electrical chiller pumps that could not be shut down. These pumps were also isolated by poly and vents cut into the plastic to ensure adequate cooling of the electrical motors. These vents had filters installed in them to prevent insulation materials from entering the sealed area. The removal method was to be by wetting and scraping, except in the electrical vault which would be by the dry removal method, due to the electrical hazards.

On May 23, 1984, the Safety Office inspected the isolation area and documented that the isolation was incomplete. This concern was passed on to the Project Coordinator and site Foreman. It appeared the contractor was in the process of isolating the area. On May 24, the Safety Office Occupational Hygienist noted removal had started. Concerned about the previous day's deficiencies, she entered the removal area and found the poly was not taped to the floor and pipe shafts D04V and C8V were not completely sealed. The Occupational Hygienist advised the Project Coordinator and site Foreman and then telephoned the Project Manager. A meeting was arranged for the following day and the Safety Office put forth its concerns relating to the contractor's past performance. The results of the meeting were that all concerns for site safety were to be directed to the Project Coordinator and he in turn would deal with the contractor.

On Monday, May 28, high FAM readings were recorded in stairwell D9Y. The Project Coordinator was advised and on inspection found the pipe chase D04V was not sealed. This situation was corrected. On Tuesday and Wednesday high readings continued to be monitored, Alberta Occupational Health and Safety was advised and six hour air samples were begun on Thursday, May 31. These samples were sent to the Alberta Occupational Health and Safety laboratory for analysis. Meanwhile, FAM ten minute readings were continued. From time to time during this period, readings of up to 6.4 fibers/cc of air were recorded. On the morning of Friday, June 1, six 10 minute FAM readings and one 100 minute reading were taken in the stairwell and Dean's Office area. Readings as high as 9.77 fibers/cc of air were obtained. Alberta Occupational Health and Safety were once again advised and requested confirmation of readings. The samples taken on Thursday had not been processed at this time. The Manager of Safety advised the Director of Buildings and Grounds of his concerns and was told to wait until Monday to see if things improved. On Saturday and Sunday, no removal took place as the Maintenance Department carried out scheduled maintenance on the electrical system. All power was disrupted to the building. Maintenance personnel worked in the electrical vault entering and leaving by the constructed tunnel. The Safety Office monitored on Sunday evening and fiber counts dropped to 0.05 fibers/cc of air.

At 9:00 a.m. on Monday, June 4, the Safety Office received a call from the Dean of Engineering's Office with a complaint of dust in the area. The Safety Office responded and FAM readings showed counts as high as 37.69 fibers/cc of air. Other readings in the area were over 30

fibers/cc. In consultation with the Dean, the office and adjoining areas were evacuated. The Project Coordinator was advised and by noon the entire "C" and "D" Blocks were evacuated and secured. Appropriate management personnel were then advised of the actions taken. At 1:30 p.m. we received confirmation of the high asbestos count from one to four times occupational exposure levels. At 2:30 p.m. an order was written by Alberta Occupational Health and Safety for closure of the building. Fans in the building were shut down and all removal work suspended. By the next morning, June 5, fiber levels had dropped to 0.5 fibers/cc. That afternoon an inspection of the sub-basement area found the pipe chase 02V was not sealed, this leads directly to the Dean's area on the second floor. It also appeared that two fans had been entered, tape had been removed from the doors and the poly barrier had been cut or torn.

Extensive investigations failed to uncover why the plastic had been breached and the tape on the fan doors disturbed. Further investigations found leaks in the air plenums. One of these on the vacuum side of a fan was four by six inches and had not been sealed prior to the removal. Meetings were immediately held and a clean up strategy devised. The contractor made necessary repairs to the the containment barriers and continued the asbestos removal project. The fan system was placed on 100 percent fresh air and exhaust. Press releases were prepared and the University Union was advised.

This shutdown was at first criticized by the Project Manager as he felt the Safety Office proceeded without having the necessary authority or facts at hand. The FAM results were frequently in question. The monitor, a sensitive electronic instrument, required a fair amount of maintenance. Problems developed from dust on the mirrors, respray materials coating the optics and alignment problems. It also counts any fibers in its set range, not just asbestos fibers. The problem in the Dean's Office area was originally attributed to dust which entered from an open window rather than the escape of asbestos from the removal area. The Safety Office's subsequent investigations showed this to be a false assumption and in fact a major contamination occurred in the "C" and "D" Blocks, Energy Transfer Laboratory and Bridge Wing of the building. Blocks "A" and "B" were not affected as their supply and exhaust air were on a different system located in another block of the building. (See Figure 2)

The doors to the contaminated areas were chained off by Campus Security to prevent unauthorized entry and signs posted on these doors advising personnel of the hazard. By Tuesday, work was underway to relocate offices in the areas of the building which were not affected. This involved running new telephone lines and adjusting office space.

Several meetings were scheduled to map out a plan for decontamination of the building. This involved the air handling systems and all horizontal surfaces, as well as blinds, curtains and rugs. The Project Manager arranged daily early morning site meetings to evaluate the prior days performance and to schedule the day's work. Personnel from Physical Plant, Safety Office, contractors, supervisors and the Project Manager and Coordinator attended these meetings. The asbestos removal continued as contractors were engaged to clean the air handling systems and area cleaning. All entrances were sealed with poly and doors taped shut.

The Safety Office organized a number of employees from the faculty to perform around the clock air sampling of perimeter areas and to document the readings. Because of the emergency evacuation, employees were requesting permission to re-enter the building to secure experiments and/or retrieve papers, books or other necessary materials. We arranged this, much to the dismay of the Project Manager. Employees requiring entry had to obtain clearance from their department head and then at specified times would meet at the building entrance to be fitted with a respirator and given safety instructions. All personnel entering were required to sign in and out. Eighty-six entries were made over a twenty day period. This allowed a number of crucial experiments to continue.

Once the ducts were cleaned, the cleaning contractors started the surface cleaning. Upper areas were cleaned first and floor areas last. Where possible, areas were vacuumed by use of vacuum trucks, HEPA filtered portable vacuums or by damp wiping and mopping. At one period, the contractor experimented with a rag impregnated with a sticky (tacky) wiper. This was found to be ineffective as the fibers tended to bond to the surface being cleaned. The final solution was use of a vinegar and water solution. Instructions were given to the cleaners to wipe in one direction only, folding the wiper when it became dirty. This method showed a significant improvement in reducing contamination.

We were confronted with the problem of how to determine when an area was free of contamination and ready for occupancy. Air samples alone could not be used as a measure of successful decontamination. Air sampling indicated only airborne asbestos fibers. Filter paper swipe tests were used to evaluate settled fibers on horizontal surfaces. Delay in analyzing swipe tests prompted us to search for a more efficient solution. The Department of Geology and Geophysics, at the request of the Safety Office, ran swipe samples through their electron microscope to identify asbestos fibers. It was concluded that this method was satisfactory for decontamination assessment. The Department of Biology provided a technician to operate a Scanning Electron Microscope. A counting technique was developed to indicate no fibers, moderate fibers, or many fibers. This method was discussed with the Alberta Occupational Health and Safety Division. Small pieces of scotch tape were used to obtain samples, then the sample was identified and given to the technician to mount and count. Most counting was done after normal working hours so results would be available the next morning. On several occasions, whole areas would have to be recleaned due to high asbestos counts on surfaces. Once the fans had been cleaned, the inside of the fan housings were sprayed with an adhesive to seal any loose fibers left behind.

Prior to reoccupation of an area, all tests had to be satisfactory. This included, tapes, swipes, FAM and six hour air samples. Once an area was declared decontaminated, the fans were restarted and ten minute FAM air samples taken in various locations within the sealed area. The system operated on 100 percent make up and exhaust air. Further samples were taken in approximately twelve hours. This was followed by an inspection from Occupational Health and Safety. When everything was satisfactory the area was reopened, with "D" Block being the first. Air handling systems were switched to normal operation on September 14.

The Engineering Building, as a result of this contamination incident, was closed for 44 days. The cost of asbestos removal, relocation of staff and decontamination was $346,000. During this clean up period, the Safety Office took 1,224 samples.

The asbestos removal contractor, on completion of the sub-basement contract, moved his equipment to the next project in our Science B Building. Safety Office personnel found his equipment had not been decontaminated This was reported to the Project Manager. Shortly after this episode, the contractor was dismissed from the job.

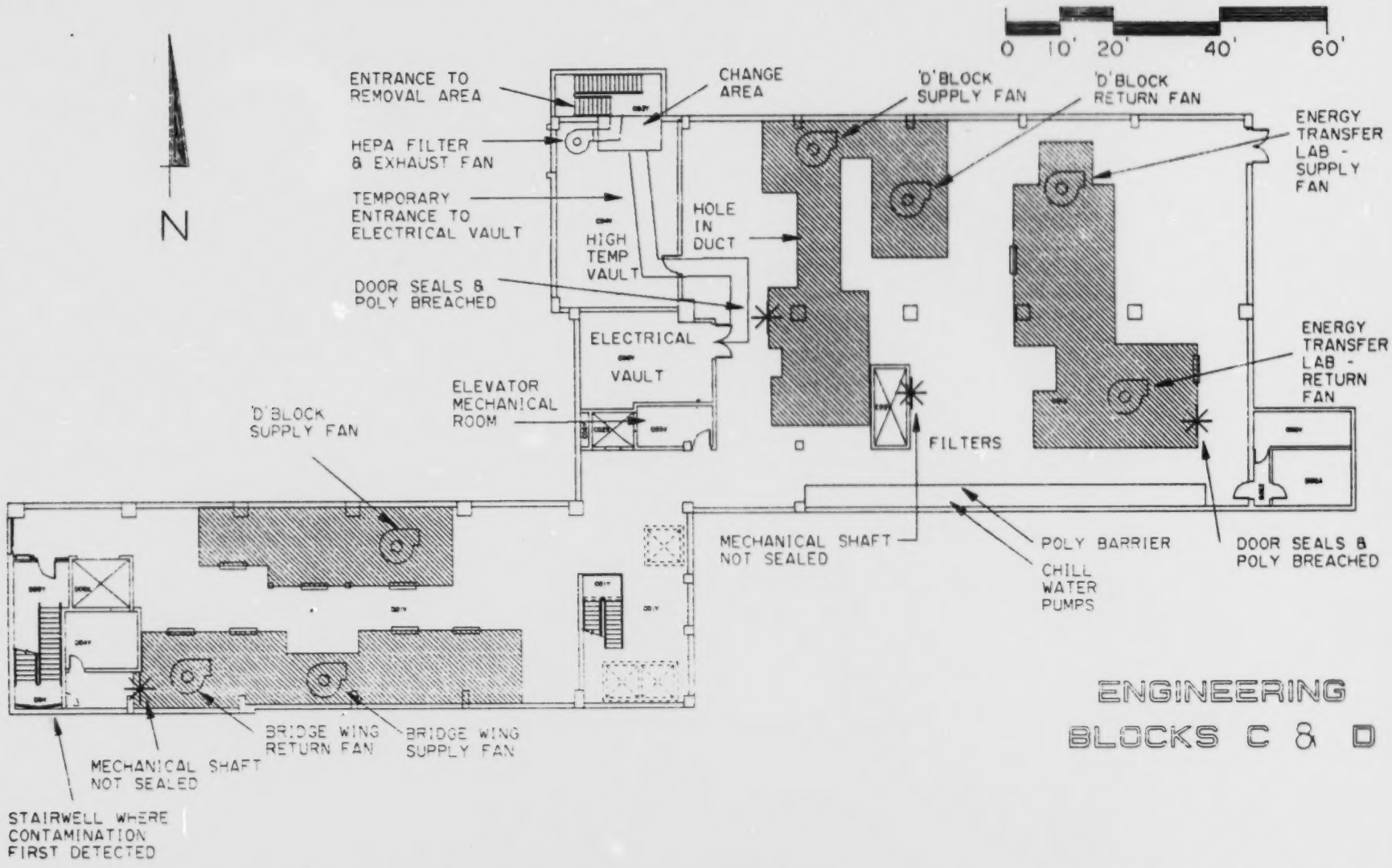
As a result of the contamination incident, lawyers representing the University's insurance carriers filed suit against the contractor to reclaim insurance costs as well as $59,499 of uninsured University costs. The Project Manager for the University was designated as the contact person to supply our insurance lawyer with the necessary information. He was required to attend an EXAMINATION OF DISCOVERY, which is an informal process whereby the solicitor representing each of the parties is entitled to examine representatives of the other parties to the action. Witnesses are examined under oath. The outcome of this was in favor of the University's insurance carriers.

In retrospect, this was a preventable occurrence. Previous poor performance of this contractor was well documented, with no apparent positive results. These poor performance incidents called for more vigilance on behalf of the Project Coordinator. As Manager of Safety, I failed to document concerns to my Director in writing. These were passed verbally only. It was crucial to maintain a good working relationship with the Project Manager and Coordinator during these projects. I firmly believe that the Safety Office must have authority to make the decision to close or stop any operation which is deemed to pose a health or threat to life of any University community member.

As a result of this incident, all further asbestos removal projects require Safety Office inspection, including smoke tests of sealed areas.

On the lighter side, I received a memorandum from the Dean of Engineering upon completion of the project. I quote him from his memorandum, "Looking back on the incident which was finally closed less than a week ago, one positive result is that we now have the cleanest buildings on campus."

By the way, my children's train set was sold to our Project Manager!



ASBESTOS REMOVAL AREA

FIGURE 1

BEST COPY AVAILABLE

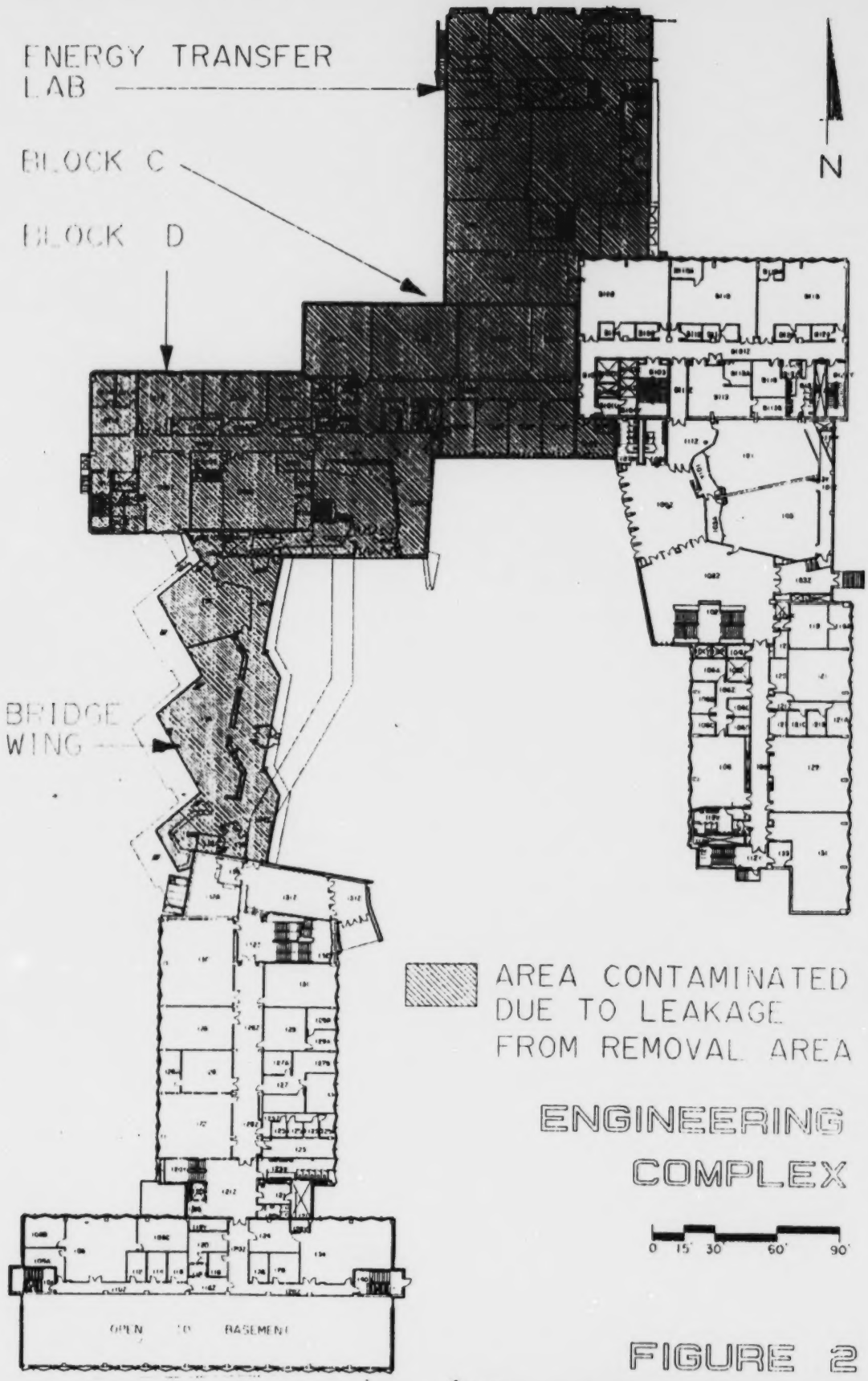


FIGURE 2

BEST COPY AVAILABLE

Yes! We Do Windows: How to Select/ Manage a Contract Maintenance Firm

Edward L. Smith
Director of Physical Facilities
Lincoln College/WFF Associates

Introduction

Some time ago I attended a workshop on contracting for housekeeping services. According to the presentation the first service that was cut was window cleaning. While that indeed is one way of cutting costs, it will also after some time alter the look of the building. It will also change the outlook of the building's occupants.

A few years ago I was being interviewed by the president of a small college in his private office. The windows were so dirty and had so many paint splatters on them you could not see out without getting next to the glass. Those windows were cleaned the day my contract started and they are still being cleaned.

While a reduction in services may equate in eventual savings due to reduced labor or contractor costs, it may also result in reduced retention of valued students or faculty and staff. It may also result in reduced new enrollment due to the way prospective students or their parents perceive the institution. They may well equate the way a building looks to the way the people at the school perform. Do clean buildings make for a better place to live and work? You bet they do!

Considerations

Advantages of In-House:

More complete control.
Results when you want them.
May be more or less cost effective.
You may have more complete authority for changes.
(Without paper work and without increased costs and maybe without extended completion dates.)

Employee pride in a job well done.
Enables you to maintain an experienced well rounded staff.

Disadvantages of In-House:

Not enough time or staff.
Not sufficient qualified personnel.
All liabilities are yours.
If projects are not completed on time and in a professional manner your department's credibility may suffer.
May not be cost effective.
Requires that you have sufficient staff to accomplish preplanning, inspections and follow-ups.

Some Advantages of Using a Contractor:

Eliminate employee turnover (hiring and firing).
Reduce overall labor costs.
Reduce insurance costs (especially liability and workman's compensation).
Improved production by improved training.
Increased frequencies of maintenance.
Not bogged down in university politics.
More cost effective overall.
Better organization and professionalism.
Should provide adaptability or flexability.

Some of the Reasons to Consider Contracting:

To obtain specialized services.
To obtain infrequently used services.
To avoid capital costs.
To obtain greater efficiency and economy in providing services.
To meet peak or overload requirements.
To remove a constant source of irritation.
To provide a quality of service that you are unable to provide in-house.

Some Types of Contracts:

Director or Manager only.
Director/Manager and Assistant Directors.
Complete Physical Plant Department.
Selected departments or trades only.
The most common today is Campus Services or Custodial.
Followed by Grounds, Pest Control and Snow Removal.
The least common is a full house contract that provides all staff, all supplies and all equipment.

Contractor Selections:

Pre-screening:

Ask other colleges and universities who they use and find out how satisfied they are with them.
Ask each potential contractor for a list of both present and former clients and the name of the contact person at each site.
Interview as many as you can contact; more than one person at each site if possible.

Visit as many sites as you are able to. Find out what people like and what they don't like about each contractor. Does the contractor's employees look like you would want them on your campus? Do they look as good as or better than your own employees?

Requests for Proposals (RFPS):

It is imperative that you know what you want; what you need; and what you expect from a contractor. You have to put all of this information down in writing.

Many times it may be prudent or wise to use a consultant at this point. How can you tell a contractor what your requirements are if you yourself don't know what is needed?
Some thoughts: (1) Must have or do. (2) Need to do sometimes.
(3) Nice to have but not essential. (4) Would like to have.
(5) Definitely do not want. (6) Your expectations.

Evaluation of Proposals:

If you have done your homework, you have a document that outlines all of your requirements. You need to compare each point of each proposal with each point of your checklist. If there are deviations, are they acceptable? Will it work for you? Is it what you want?

Bidding:

At some institutions you can now ask that contractor for a bid based on his proposal or his proposal as changed by you. It may or may not be necessary to obtain additional bids.

Your biggest challenge is to get each contractor to bid the same thing. Service is not like a lawn mower in that technical specs can be obtained and followed by each bidder.

Selection:

A well written contract will reduce the chance of misunderstandings or arguments by stating in clear, concise terms what each party has agreed to do. If a portion of the contract is unclear or vague or may be interpreted differently by each of the parties, it should be rewritten to eliminate this ambiguity. If all parties understand at the beginning of their relationship exactly what is expected of them, there is less chance of arguments in the future.

Management of the Contract:

The best written contract is worthless unless it is properly managed. A quote that I have tried to follow is one that will work well for you. "INSPECT WHAT YOU EXPECT."

Liaison

Someone from your staff needs to be appointed as the contract liaison or administrator. You need to give this person the

basic authority to resolve most problem areas. This person must be knowledgeable enough to answer questions and capable of taking action as needed. There can only be one person who the contractor reports to.

Inspection/Compliance:

A written inspection check list will be necessary to make the contract work well. A copy of any inspection result needs to be given to the contractor immediately after each inspection. It should be worded in such a way as to leave no doubt about what you require and it must tell the contractor when it has to be completed by.

Change Orders:

All change orders should be in writing. If you and the contractor compromise on a change, it should be signed by both parties and a specific cost agreed upon. It may be something that is difficult to price. In this case you may want to put a cap on the cost. Not to exceed $4,500. You may want to have it on a cost, plus basis. The contractor will bill you his exact cost plus a fixed percentage. 15 percent, 20 percent, 25 percent - whatever you both can agree on or feel is fair.

Thoughts:

Take a service survey of your facility right now. Take another right before a contractor starts and at regular intervals thereafter. Don't just sit on the results, use them to improve services and your image.

Insure that your contractor understands that you require a quality control program to be in place from day one.

A good quality control program can:
Eliminate or reduce complaints.
Insure a reduced cost.
Increase productivity.
These all combine to give you a high quality program.

A longer term contract that you and the contractor can live with will normally be of greater benefit to each of you. It will give you a fixed cost for your budget for the next two, three or even more years. Many times this will enable you to negotiate a better price per year. You and the contractor each benefit with a long term agreement.

A good contract does not cost, it pays in benefits for you and your department and for your university. I have asked Dr. Jack Nutt, President of Lincoln College, to explain his feelings about contracting. His thoughts are contained in the attached letter.

Lincoln College

300 Keokuk Street
Lincoln, Illinois 62656
217-732-2641

President

In 1982, Lincoln College began contracting for custodial, maintenance and grounds services. While it is true that if an outside company can make a profit, a college should be able to operate these services efficiently. The sad truth is that most do not.

Very few small, private colleges have employees that are proficient in grounds care, custodial techniques, plumbing, electricity, carpentry, locksmithing, painting, food preparation and retail manangement. Thus, some educational administrator serves as director of buildings and grounds, cafeteria supervisor or bookstore manager. The duties take time and detract from the time necessary to do what they were trained to do.

These services can be a negative, or a positive, student recruitment tool. Everyone is impressed with clean buildings, attractive grounds, functioning equipment; tasty, well-prepared food, bookstores that are attractive and well-organized. However, in this time of limited dollars and deferred maintenance, these areas suffer first and most.

Show a mother a dirty dormitory and she won't care about the high quality of your English department. Show a father a bland, unattractive cafeteria with trash on the floor and he won't care that most of your faculty are PhD's. Force a student to live in a crowded, dirty environment with poor climate control, eat unattractive, boring meals three times a day and that student will not be back next year.

Look at these services as an investment in admissions and retention. As a college, do what you can effectively do and what you can't effectively do, hire done by professionals. It will not only save you money, it will make you money.

J D Nutt

Jack D. Nutt, Ed.D.
President By-Ls

Contracting for Trades Services

Patrick J. Lawlor
Assistant Vice President for Facilities Management
Virginia Commonwealth University

I. Background

This is the session on Contracting for Services in Physical Plant Trades. I'm happy to share with you our experiences at Virginia Commonwealth University in the area of private contracting and some experiences of others that we've picked up along our way.

I believe I should share with you first exactly where we are today. First, let me explain some things about our University:

A. We are a state university with two campuses in the heart of Richmond, Virginia. We have an active medical school, major ambulatory care facility, a 1,000 bed hospital, 6 major non-medical schools, and 6 schools associated with the medical college. We have an enrollment of 16,696 FTE, a faculty of 1,800, and a staff of 2,400.

B. We have 5.7 million gross square feet under roof in a combination of historic buildings, major academic buildings, and former residential structures.

At the present time, we contract:

HVAC: National corporation performs full maintenance on HVAC equipment

Elevator: National corporation performs preventive maintenance and repair services on 140 pieces of vertical transportation.

Pest Control: Local company, fully certified to treat all buildings to effect complete eradication of all pests.

Waste Removal: Corporation removes all infectious waste from Hospital and lab areas.

Sterilizer: Local contractor furnishes all labor, tools, and equipment to provide inspection and preventive maintenance on sterilization equipment.

Window Washing: Two contractors clean all exterior windows in both hospital and college buildings.

Elevator Technologies: Contractor performs routine and periodic inspections of vertical transportation units.

Emergency Generator: Contractor performs preventive maintenance on generators at MCV Hospital.

Multi-Trades: Local contractor performs renovation services on University buildings.

Concrete Services: Contractor is responsible for repair and replacement.

Painting: Contractor performs on-call painting.

Carpentry: Contractor performs on-call carpentry.

Plumbing: Contractor performs on-call plumbing.

Electrical: Contractor performs on-call electrical work.

II. Mechanics and Analysis

The next issue is simply: why contract?

There's really only two reasons that I can think of that are valid:

- If the economics clearly indicate a substantial savings, and,

- Where the existing University forces do not have the expertise to perform the tasks.

It's probably appropriate at this point to consider economics.

The decision to contract is a "Make-Buy" decision. The internal costs that must be considered against contractors bid are:

1. The cost of trade labor involved (including fringes).

2. The cost of typical materials needed.

3. The cost of supervision up to a level which would be eliminated if the specific trades work were contracted out 100 percent.

In our view, if in-house costs are within up to +10 percent of contractors bid costs, the work should remain in-house. The reason is really an undimensioned judgement call. The dismantling of the in-house ability to perform a trade in fact intimates a later high penalty to reestablish the work "in-house." Additionally, unless the trades work is being done unacceptably, there is an ethical non-economic issue in a typical university that does not pertain in a private industry.

If the contracting decision is to be made and if the effect could mean a significant layoff of personnel, it is imperative that the senior administration of the university and its Board be aware of these repercussions.

II. Basics

There are some basics that probably should be addressed early on. First, let's look at advantages and disadvantages of service contracting for the typical university:

1. The private contractor is clearly motivated by profit pressures and unencumbered by public personnel regulations which may often be counterproductive. In a word, the contractor often is cost competitive and represents a distinct savings opportunity for the university. In a survey we've just completed, 28 universities contacted and analyzed indicated a clear and documented savings over like inside costs (this, despite the private sector pressure of overhead, profit, and taxes).

2. The private contractor comes to a trade commitment with considerable expertise in his area of work. The competitive contractor must stay aware of and probably uses efficiency-enhancing developments and equipment in his trade.

3. The contractor relieves the university of some of the burdens of day-to-day supervision (but adds others!). Such issues as hiring, firing, training, selection, and direct supervision, often inefficient in public entities, are obviously carried out by the contractor.

4. In some highly specialized or seasonal trade areas (instrument maintenance, etc.) the university may not be able to justify a full-time staff. In such situations, a private contract, used when needed, may be an appropriate solution.

As to disadvantages:

1. In our estimation, the chief disadvantage (or challenge) to aggressive, widespread private contracting is the issue of responsiveness, appropriate coverage, and perceived responsiveness. In our urban university and hospital, activities obviously go forward 7 days a week, 24 hours a day. We must be available to respond to emergencies and be available also at odd hours to do more routine work at times when space is available. There is, in my view, only one option open to solving this problem for the busy university; that is, retention of a cadre of key trades for particularly sensitive and odd-hour coverage.

2. The next disadvantage in my mind is an issue most involved in beginning a contracting effort; namely, the disposition of in-house forces.

I think if it is at all possible to do so, the Facilities Manager should allow attrition to handle the question of superfluous in-house personnel. We have found in some areas (such as housekeeping) that a normally high turnover rate will allow for a smoother transition from "make" to "buy."

3. There is also the issue of the contractor's lack of in-depth knowledge of the university, its procedures, and its political realities. This issue must be addressed with care, planning, and time if at all possible.

4. There is also the challenge of maintaining the initial cost benefits and commitments provided by the contractor as the contract relationship continues over time. It is unfortunately often a repeated reality that as a contract matures, costs and responsiveness issues grow.

5. In some areas of work, the combination of scarce trained resouce and high liability risk urge the university to find outside expert assistance on a regular basis. One example for us in Richmond is elevator maintenance.

As mentioned elsewhere, we have examined the experiences of 27 universities and universities in the private contracting of trades. The results indicate that the overwhelming majority of these institutions have experienced a dimensioned and significant savings in operating costs through contracting, but there has also been an underlying challenge in the successful administration of the contracts themselves. In some cases, the use of private contractors has been abandoned due primarily to difficulties experienced in the apparent selection and subsequent management of the contract relationship.

It would appear important for us to look at the contractor selection process and then the management of the contracts.

III. <u>The Selection of the Vendor</u>

The selection process might well be subdivided into 2 separate phases and reviewed:

- The preparation of trades contract specifications.

- The bidding and contractor qualification process.

1. Trade Contract Specifications: Probably no single issue in this entire subject is more important to a successful contractor relationship than the care with which this process is completed.

The Physical Plant Administrator needs to be aware of and directly involved with 9 areas of concern:

a. Contractor legal responsibilities (bonding, insurance coverage, indemnification issues.)

b. Contractor size and financial ability. Will the contractor be able to perform to the university's expectations?

c. Such contractor controls as security checks, worker identification, adherence to university policies on hiring, firing, etc.

d. A detailed description of the nature of the work contracted for.

e. As detailed as possible a description of the work quality level and frequency level contracted for.

f. The degree of supervision (workers/supervisor/on-site manager) to be supplied.

g. Details of contractual understandings (authorization of invoices and payment methods, timing, and renewal of contracts).

h. Development of penalty clauses for nonperformance.

i. Development of clear lines of communication and the identification and approval of specific contractor personnel responsible for the contract.

2. Bidding and Contractor Qualification

Usually, the bidding process is dimensioned and directed by the University Purchasing function; however, within these dictates and constraints, there are 3 important points to consider:

- A pre-bid conference on site with the work site open is imperative.

- The lowest cost should not be considered the entire criteria.

- Rather, a combination of cost and contractor perceptiveness of the work, apparent corporate ability, reference qualification, and chemistry between the firm and the university are critical.

3. Contract Management - And Afterwards

In our experience, there are 4 actions which will help in maintaining a profitable relationship:

- Requests for payments based on unusual actions should follow a clearly documented path of review.

- Regular senior communication should be maintained between the university and the contractor.

- A staff of quality inspectors should be maintained by the university and used vigorously.

4. In closing, it is our opinion that the "make-buy" decision associated with trades contracting is not a one-time issue. The trades labor market surrounding a university is not a fixed issue. Market values change over time (as do internal conditions within the school) and a carefully timed regular review should be maintained.

IV. Summary

In closing this discussion, I believe it is important to leave with you some suggestions:

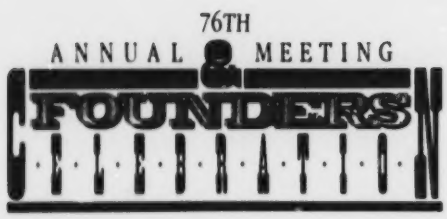
- Each of our institutions are in different markets.

- Each have differing priorities.

- Each is in its own physical settings.

- Each have differing levels of in-house middle management to support contracting.

We've tried to reflect our beliefs in trade contracting, but they derive from our institution and its surroundings and milieu. Our findings and strategies may not be appropriate for your needs.



Communications and Public Relations

John

Sherry

Enhancing the Physical Plant Administrator's Image by Writing Technical Papers and News Articles

John D. Rulfs
Associate Director of Physical Plant
Sherry L. Rulfs
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The environment of the university campus is certainly a unique one. Very few places require as much cooperation from as many different types of people in order to operate smoothly. The physical plant is of critical importance to all departments on campus. Even the most brilliant and educated professor can't teach classes if there are no lights in the classroom. A professor with Ph.D. in physics from Stanford is very dependent on an electrician whose education may consist of a high school diploma and a year of technical school. Conversely, the electrician's job wouldn't exist if students weren't seeking a college education. The mutual dependence of their relationship is certainly evident, but any physical plant employee or administrator will point out that the academic function of a university receives most of the praise and attention, while the physical plant is usually ignored until something goes wrong. This is an unfair and frustrating situation, and most physical plant administrators would certainly like to overcome it.

The solution to the problem lies in one of life's hardest lessons: When other people make the rules, we either play by those rules or find a new game. On a university campus the rules are made by people who feel that academics take precedence over everything else. Academic leaders respect (and even revere) intellectual activity above everything else. The professors who work for them are judged by whether or not they publish books and journal articles. Those who publish receive more respect and better pay raises than those who don't, and professors who fail to publish often lose their jobs. These are the rules of the academic game, but these rules also affect the physical plant of any school.

University presidents are academic leaders who have been especially successful at playing by the rules of the academic game. Therefore, they

are unlikely to change the rules, and they judge their subordinates by whether or not they have succeeded at the same game. The physical plant administrator has the opportunity to advance his/her career and gain the respect of the school's academic leaders by playing the game by academic rules. The purpose of this paper is to help physical plant personnel understand and play by academic rules. One of the most effective ways to play the academic game is to write and publish technical papers.

But I Can't Write!

Yes, you can. Writing technical papers is much easier than you think. This type of writing is not like that in an English class in which you are assigned a very abstract topic. In technical writing you get to choose the topic which will be very concrete in nature. The topic you choose will be one in which you have a great deal of knowledge through either your education or your experience. Think for a moment about how much you have learned from other plant administrators when you just sit down and "talk shop." The idea behind technical writing is to take that shop talk a step further by putting your expertise on paper and sharing it with a larger group of people by publishing it in a professional journal.

If you don't feel confident about writing, stop for a minute and think about what you do on the job. Most physical plant administrators handle routine correspondence that requires good basic writing skills and sometimes calls for a great deal of tact and finesse. You may have to write those letters and memos very quickly, but when you write an article for publication, you have more time to think about what you are saying. Sometimes that hurriedly written correspondence can have a positive or negative effect on your professional reputation; however, when you write for publication, you have everything to gain and nothing to lose.

How Do I Go About Writing?

An article is constructed in much the same manner as a building; it's a step-by-step process that involves a basic sequence and a few simple guidelines. The following steps will help you in planning and structuring an article.

Step 1: Pick your topic. This should be easy, but sometimes we make it very difficult when we don't look at what we do at work every day. To find a topic think about what your department has been doing and what problems have you faced and solved. You solve problems constantly, or your physical plant operation would collapse. What kinds of new products or innovative practices have been used in your department? Have your employees been using old products in new ways? Don't forget those questions that other plant administrators have asked about how your department manages certain issues. Finally, recall the last time you heard two or more people disagree about alternative ways of handling a situation or problem.

Step 2: Decide the purpose or purposes of the article. The four basic purposes of an article are to (1) inform, (2) instruct, (3) persuade, and (4) document. Many articles have more than one purpose. For example,

this paper is designed first, to persuade readers to write technical articles and second, to instruct them in the basic procedures involved in writing such articles. Just remember that adding more purposes will make the article longer.

Step 3: Choose the journal before writing the article. Choosing the journal before you begin writing will allow you to produce an article that fits the pattern used by that particular publication. After you have chosen your journal, look at the length of the articles it usually prints. Does the journal specify a certain length? If not, try to write an article that is about the same length as its average article. Does the journal specify a specific style for citing sources? If so, invest in a style manual, or better yet get one for yourself and another for your secretary. Check the articles and determine how formal that particular journal is in citing sources. Most technical journals tend to be informal in this area.

Look at the type of article preferred in the journal you have chosen. Is the usual approach technical or non-technical? Are the articles theoretical or oriented toward problem-solving? Hopefully, you will find a journal that is leaving a subject matter gap that you could fill.

What kind of language does the journal use? Is the language formal or informal? Read a few articles to get an idea as to the kind of language the writers are using and try to pattern your writing after what is already in the journal. Remember, it is usually better to choose a common, easily understood term instead of a technical one. Don't forget that many of your readers may need to have certain terms defined. It's better to tell a reader something he/she already knows than to leave a term unexplained.

Sometimes writers find that they need to round out their knowledge or support something they already know with a little expert opinion. When you need to do this, don't forget that the library is there to serve you just as it does the faculty members. Using the library is faster and much easier than it once was. On line computer terminals help us find books that we need. Computer searches make finding journal articles quick and easy. Even if your school's library is small, you can get what you need because interlibrary loans can obtain books you need, and journal articles can be electronically transmitted to you in one or two days. Chances are, the director of the library owes you a favor anyway, so don't hesitate to call it in.

Step 4: Outline your article. Outlining is the most important step in any kind of writing, but many writers fail to outline articles before beginning to write because they feel that it takes too much time. This neglected step is well worth the time you will spend. Outlining keeps you organized and prevents you from getting off the subject. Think of the outline as a skeleton that holds a body together.

The article and its outline have three critical parts: the introduction, the body, and the conclusion. The introduction catches the readers' interest and lets them know that the article is worth their time. In the introduction you will tell the reader what the article is about and why it

is so important. The introduction of this article discusses a common problem faced by most physical plant administrators and proposes a solution to the problem. In this case, the purpose was directly stated at the end of the third paragraph.

The body is the main part of the article and will be longer than the other two parts. The body tells the reader what he/she needs to know. Usually, the body of an article is intended to give the reader important information, so it must be well organized. As you write the body of your article, remember the purpose(s) of the article that you chose in Step 2 and keep them in mind as you work. Most writers enjoy working on the body of an article because they are discussing something that is important to them.

The third part of any article is its conclusion which serves to tie up the loose ends and may contain helpful suggestions to aid the reader in his/her professional setting. If you have written about a new method for doing something on your campus, you'll want to say that you have been very pleased with the results. If a product you have discussed is very good for some uses but ineffective for others, this is a good place to let the reader know about any limitations. Remember that an article without a conclusion leaves a reader feeling the way a television viewer does when the station goes off the air with ten minutes left in a program.

Step 5: Write your first draft of the article. After writing an outline which is the skeleton of your article, you are ready to add some flesh to the skeleton. Don't leave the outline in your desk drawer. Keep it in front of you as you write to avoid leaving out important information or getting off the subject and dwelling on minor details. As you write try to keep in mind whether you want the article to sound formal or informal. You will want to follow your outline as closely as possible, but writers often find that they have omitted an important detail.

Step 6: Edit the first draft. Editing is a difficult but very necessary step in the writing process. The first step is to put the first draft away for a few days. Letting it sit in your desk drawer for a short time will allow you to find mistakes more easily. Also, many writers find that when they look at a draft a few days later, they think of much better ways to express what they are trying to say.

The biggest single problem in technical writing is clarity. We know exactly what we're saying, but it's less clear on paper because our own knowledge of the subject keeps us from seeing the fuzzy wording. To help make your writing more clear, have someone else read your paper. Ideally, this should be a person who is not already familiar with the paper and will be able to catch wording that is unclear or confusing. If time permits, go through the editing process a second time to fine tune what you have written.

What Else Do I Need to Know?

As you write, try to make your wording strong and simple. Use active rather than passive verbs because they are simpler, more direct, and more expressive. The following examples show how much more effective active verbs can be.

Passive: The project was authorized by the vice president.

Active: The vice president authorized the project.

Passive: One hundred work hours a week are saved by this method.

Active: This method saves one hundred work hours a week.

To lead to the use of active verbs, think of ways to leave out words like "the," "by," and "of." The best rule of thumb in writing sentences is that the writer should strive to be as direct and simple as possible.

When most of us read something, few things are more irritating than having to wade through a swamp of unnecessary words. Writers should strive to use as few words as possible to say as much as possible because clean sentences are so much easier to read and understand than wordy ones. The following examples show the difference in a wordy sentence and a clean one.

Wordy: The assessment of the success of the experiment was made by the scientist.

Clean: The scientist assessed the experiment's success.

Wordy: The technician conducted an examination of the cracked beam.

Clean: The technician examined the cracked beam.

Wordy: Bill Ryan, who is an engineer, designed and evaluated the spring testing machine.

Clean: Engineer Bill Ryan designed and evaluated the spring testing machine.

Professional journalists place very high value on using clean sentences; therefore, news stories on the front page of your daily newspaper are an excellent model of how to make your sentences very direct and avoid wordiness.

Another way to make your writing more appealing to the reader is to limit your use of technical terms and jargon. Your readers may lack your

expertise and will appreciate simple language which doesn't keep them running to the dictionary.

Where Can I Publish My Article?

There are several sources available to publish your article. The Association of Physical Plant Administrators, which is the plant administrator's most important national organization, publishes the APPA Newsletter and Facilities Manager. Both publications welcome input from members. All of APPA's regional organizations publish newsletters and are actively seeking articles from readers.

What Other Types of Articles Could I Write?

Thus far, we have focused on the technical paper, but there are several other formats that are very appropriate for newsletters, your local newspaper, and area radio and television stations.

The News Story From a journalistic point of view, a news story differs from other forms of writing in several ways. In most writing it is important to have an introduction, a body, and a conclusion. Frequently, the conclusion contains some very important facts. However, in a news story the most important facts are in the first paragraph, and the last paragraph contains the least significant information. This format is known as the inverted pyramid, and it is used for two reasons. First, we want to grab and hold the reader's attention, and second, this format allows an editor to leave out the last paragraph or two to make the story fit into the space available.

As you write a news story, concentrate on answering the following questions: Who? What? Where? Why? When? How? There is no particular order in which you should answer these questions. Each story is different, so you will want to answer the most important questions first and the least important ones last. If a question has no significance to your story, you can simply omit it, but a news story deals only in facts. It never contains the writer's opinion, but it is permissible to indicate another person's opinion through the use of direct quotations.

Another way that the news story differs from a technical article is in the style of writing. The sentences and paragraphs should be shorter than those in a technical article. Your sentences should not waste words; simply report the story, and when the facts are given, stop. In other types of writing you begin a new paragraph when you change topics, but in a news story you should begin a new paragraph about every four to six typewritten lines. This is done because the use of frequent paragraphs adds white space which makes the small print more pleasing to the eye.

In a news story you may be discussing highly technical material, but you are reporting it to a very general audience which may not understand complex terminology. Therefore, you will want to avoid technical language and make very few assumptions about your reader's prior knowledge.

The News Feature A feature story is somewhat different from the news story in that it does more than just report the news. It deals in facts and answers the same questions as the news story, but it does allow for a more conversational tone. Longer paragraphs, more technical facts and language, and sometimes a definite introduction, body, and conclusion are found in a news feature.

The Human Interest Feature This type of feature story is attractive even to readers who may not be remotely interested in how a physical plant is operated. The human interest feature focuses your plumber who raises alligators in his spare time or your secretary who is "Mom" to five foster children. Also, this type of story may inform readers that your plant's groundsworkers planted a thousand bulbs and bedding plants last year to beautify the campus. The possibilities for human interest feature stories are endless, and your employees and others in the community will greatly enjoy them. At a later point, we will consider how this and other types of stories may be used for public relations purposes.

Photographs to Illustrate Articles

Obtaining photographs to use with your story is relatively easy because these days most households consider a 35 mm camera as essential as a television. Hopefully, you will have a serious amateur photographer in your own department. If not, you may be able to get free photography services from your school's news service or hire a journalism student who will work at a reasonable rate to either take and process pictures or just process those taken by you or one of your employees. Black and white prints are preferable, but clear color prints may be acceptable for some of the regional newsletters.

Photographs add a tremendous amount of interest to any story and definitely attract the reader's attention. However, the basic purpose of a photograph is to accurately depict the story or to illustrate points in the article, and there are some guidelines which can help you to make those photographs useful as well as attractive.

The first guideline is to take a picture of the object you want to illustrate. This may seem obvious, but a surprising number of photographic illustrations contain too much space devoted to objects which are unrelated to the topic and tend to distract from the purpose of the photograph. To avoid this problem you can take closer shots or have your photographer or photo processor reprint a picture and crop away unimportant parts while enlarging the part that illustrates your story.

A second point to remember is to make the people in your photographs look as natural as possible. If you are illustrating a story about the fine cabinet work done by two carpenters, they will look far more natural using hammers and sandpaper than they would standing side by side looking directly into the camera. Of course, it's only fair to warn the carpenters about the upcoming photograph in case they want to get haircuts first!

Third, the plant administrator must assure that all photographs are appropriate. Remember that a picture of a pretty young lady in a mini-skirt admiring a cooling tower may not project the professional image that the physical plant needs to maintain. This sort of photograph is perfectly acceptable in trade magazine advertisements, but it should not serve as a model for the physical plant administrator.

Using Articles for Public Relations Purposes

As a plant administrator, you would probably be delighted to see the results of your department's hard work publicized on television or in a local newspaper. This may be easier to achieve than you might assume. If you have already written an article for a regional newsletter, you may be able to get some extra mileage from the story by submitting a copy of it and any pictures to your local newspaper, the campus student newspaper, or to your school's news service. You may want to revise the story slightly according to the types of readers, and you can expect a newspaper to edit a story to suit its own style. Accompany the story with a brief letter which tells the editor to feel free to publish the story as is, edit it, or to send a reporter to write the story in the newspaper's preferred style. Similarly, you can send your story and photographs to television and radio stations inviting them to use the story or send their own personnel to cover it. In dealing with the media, remember that the timeliness of a story is critical. The media is usually interested in campus news, so with just a little more effort, you will have an excellent way to do some public relations work for your department.

Other Professional Considerations in Writing

Whenever we talk about writing for publication, we must think about ethics and libel. This is a sticky subject. As we read the newspapers and watch television, we may wonder if ethics and concern about libel even exist anymore. However, we are professionals, and we want our writing to reflect it. Always be factual; present both sides of the issue, and avoid expressing your personal opinion in a news story. In a technical article or feature story we need to avoid the use of brand names. When comparing several types of products, give the good points of each. In discussing individuals, always stress only positive points.

What is libel? Libel is when we write and publish words about somebody or something that are not true and reflect unfavorably on a person, product, or service. If faced with a libel suit, it is the writer's and publisher's responsibility to prove that what has been said is true. Those alleging libel do not have to prove that the statements are untrue. Libel is a complex legal topic, but for our purposes we need to keep two important things in mind. First, be certain that what you say is true. Second, be positive about what you say. For example, if you are writing about a new roofing product you are using that has solved all your problems, focus on the new product. Don't talk about the old one and all the problems it caused. Libel is a major consideration, but it isn't a major problem when we remember to keep our articles and stories upbeat and positive.

Will Writing Really Help Me?

Writing articles for publication is important in more ways than one. First, it will cause you to become more professionally active and spend more time with physical plant administrators from other schools. Second, and most important, publishing articles is a measure of a person's worth to academic administrators like university presidents. As a physical plant administrator, you may not agree with this measure of worth, but you can't change it. Therefore, your best alternative is to do the things that the rule-makers value the most. Writing papers for publication is a relatively easy process that gets easier with practice. By writing papers, you will be able to stand on more equal ground with academic leaders who make decisions about your physical plant operation. The rules of the academic game won't be changing, so it is up to the physical plant administrator to play by those rules.

Sherry L. Rulfs is an Assistant Professor at Stephen F. Austin State University. She holds a doctorate from Texas A & M University and teaches in the Department of Secondary Education at SFASU where her duties include supervising student teachers. Dr. Rulfs has experience in a business setting and has extensive experience teaching journalism and English in public schools and directing student publications.

John D. Rulfs is Associate Director of Physical Plant at Stephen F. Austin State University. Mr. Rulfs' professional background includes service as an officer in the U. S. Navy; he has extensive experience in University public relations and photography and was employed as the Associate Editor of a newspaper. He is currently the Editor of the CAPPA Newsletter.

Unique Approaches to Marketing the Physical Plant Organization

Robert H. Clawson
Assistant Vice President, Facilities Management
University of Connecticut

A survey of users of Physical Plant services at the University of Connecticut indicated that although these users had a perception of increasing quality and satisfaction with the services provided, there was a substantial lack of knowledge about the scope of services available and how to access these services.

This presentation will outline the marketing approaches taken by the Office of Facilities to implement the findings of this perception survey and will detail the specific programs initiated to overcome this lack of knowledge about the Office of Facilities services and ways in which they are secured. Some of these marketing efforts are unique in a college or university setting.

During the past few years since the survey was completed, several marketing approaches have been initiated. These include the development and distribution of a Guide to Services and a Facilities Newsletter, a multimedia slide/video presentation, tours of major Office of Facilities installations, video construction status reports, and a video interview with the Assistant Vice President for Facilities Management which is presented on Connecticut Public Television several times each year. We will review each of these approaches to marketing the Office of Facilities and see examples of each. Video marketing programs can be directed to a broad range of audiences and used for orientation of new employees, used to introduce training sessions, used to showcase Physical Plant operations, and used to improve perceptions of effectiveness of the Facilities Management department. Time frame and cost information will be presented for each approach and an overview of the individual effectiveness of each will be discussed. A question and answer period will follow the presentation.

Forestalling Complaints in Physical Plant Administration

Edwin B. Feldman, P.E.
President
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Certainly the adequate and effective physical plant administrator will listen carefully to complaints, and take steps to correct them. He will keep a complaint log, and try and determine patterns. He realizes that record keeping on complaints will avoid a lot of troubles later on; and he further realizes that some people complain only for psychological reasons, such as to relieve boredom, extend their own power, gain attention, etc.

But the exceptional physical plant manager, that person with great future prospects, goes beyond simply responding. His interest is in prevention.

Let us examine, then, the sources of complaints, their causes, and what might be done to prevent them.

The "Customer"

The first complaint of the customer, that is the person being served, is:

Why does it take so long to get something done?

In other words, the basic complaint is response time. The customer feels that, with a great deal of money being spent in physical plant management (in his opinion), why should it take two weeks to replace a blinking fluorescent tube, to pick up litter from the grounds, to replace the washer in a leaky faucet, or to remove a spot from a carpet.

Slow response time creates poor internal relations, makes it difficult to obtain cooperation from other departments, and may indicate to administration that there is a lack of control or adequate planning.

Prevention: provide the type of work scheduling that causes things to get done in a hurry, while being very productive, such as "route maintenance", where workers regularly show up at certain locations to provide short-term maintenance activities; or where custodial personnel are assigned to tending and policing duties of litter removal, dispenser refill, mopping up spillages, and the like. Also, make certain that the customer has been informed by management concerning the limits of service that physical plant management is able to provide, based on budgetary limitations. Very often, unfortunately, a department's budget is cut, but the customers are not informed of this, and expect to continue receiving services as in the past.

The second complaint of the customer is:

Why do they send two people to do one job?

The customer may be incensed at the thought that, while his own budget is strictly controlled, the physical plant workers are able to waste money by having two people do the job that one person could do.

Obviously, there are jobs that require two people, such as for safety purposes in high-tension electrical work, high-ladder work, working inside of tanks, etc. Customers should be informed of this need, and it would certainly not be ridiculous to have a sign in view in each of the above cases that indicates that two workers are required for safety purposes at that time.

Another need for two workers, rather than one, is during the training of an apprentice; in this case, trainees should wear badges with half-inch lettering indicating the fact that the person is a trainee.

One can easily belittle the importance of these public relations activities, and suffer grievously from the effects.

The Worker

The worker in the maintenance, custodial, grounds, or other physical plant job has as his first complaint:

You gave me more to do than you gave another worker.

Since the basic requirement of management is to be fair, such a complaint might well be justified. A younger worker may complain that he is being given more work to do than an older worker; that the supervisor is discriminating in work assignment in terms of language, minority group, friendship, etc; that the recent hiree is being given the "dirty work" to do, etc.

Prevention: There is literally no substitute for measurement in assigning physical plant work - - anything else is simply guess work, and will lead to inequities in job assignments. Further, supervisors must be trained carefully in aspects of fair leadership.

The second complaint of the worker is:

You did not give me the tools for the job.

The worker complains that, while you are telling him that his job is important to the organization (and it certainly is!), you are denying that importance by letting the worker run out of supplies, or by giving the worker inadequate tools in terms of size and performance. The worker who regularly complains about inadequate work equipment and supplies may be thought to have a "bad attitude", but is simply anxious to get the job done, and knows that it cannot be done without the provision of workable equipment.

Prevention: Through work measurement, determine the proper equipage and supplies for each worker, attempting to provide each worker with his own uniquely marked and identified piece of equipment, that is kept locked up for his sole use. Arrange a purchasing and distribution system that never lets the worker run out of supplies. Some workers are "pack rats", hiding things away to use because they know that management will let them run out from time to time. This certainly makes the worker more wise than management!

The Supervisor

The supervisor's basic complaint is:

Management doesn't back me up in disciplinary actions.

The supervisor may find himself greatly embarrassed when he has told a worker that he will receive a suspension for breaking a certain rule, and then this is countermanded by the Personnel or Employee Relations department.

Prevention: This serious situation, which uncorrected leads to lack of supervision at various levels, has more than one factor:

1. The supervisor must be appraised of the legal ramifications of various disciplinary actions. For example, in many locations, a worker cannot be disciplined for theft until he has removed the stolen item from the premises.
2. Management must be very clear in terms of what its disciplinary procedures are, not only for the action that the worker took, but how many times that rule has been broken. This is best expressed in a "chart of disciplinary action", where the rules are listed alphabetically, and the proper disciplinary action indicated for the first, second, etc., times

that the rule is broken. Such a chart, or summary of disciplinary actions, should be in the personnel policy.

3. Supervisor's require regular training for purposes of disciplinary actions, involving such things as creating the proper paper work, obtaining acknowledgments, using a witness, etc. Role play techniques are specially useful in these cases.

4. To forestall some of these problems, some organizations require a prior clearance of a proposed disciplinary action with the personnel department.

This avoids many cases of embarrassment.

The second most frequent complaint of the supervisor, when he has been promoted "through the ranks" is:

I am losing my friends.

The promoted supervisor feels that former working friends are making jokes about him, shunning him, and staying out of his way. The supervisor has even been told, properly, by management that he should not continue to ride in a car pool with some of his former fellow workers whom he is now supervising, for example.

Prevention: The worker who is about to be promoted should be told in no uncertain terms of the old expression "it gets lonesome up there." The supervisor can no longer be "one of the gang." To be sure, the new supervisor must take positive steps to actually separate himself from his former working fellows, by his form of attire, by not continuing to have coffee break with just a couple of them, getting out of the car pool as stated above, etc. Those people eligible for promotion, on learning this, should refuse the promotion if they do not feel that they can make such a separation.

The Manager

The department head, or manager has a complaint that is sometimes rather bitter:

We are a regular target for budget cuts.

The manager becomes rather tired of being called an indirect department, that is not in the direct line of providing the organization's fundamental objective, of being classified as a "burden department", or a "necessary evil".

Where other departments are being given increases, his department undergoes arbitrary cuts. Games are being played during budgetary periods, where the manager feels compelled to submit an inflated budget so that the normal reductions that come about bring him back to an operable condition; he wonders if other departments are required to go through this charade.

Prevention: Management is the perfect prevention for this problem. Where an operation has been developed and is run on experience, past history, and the like, it is only natural for management to question whether or not the department is at the optimum level of performance.

But where the department has been staffed and equipped through measurement - - that is, the application of time standards to the numbers of items to be maintained or the square footage of floors to be cleaned or the acres of grounds to be taken care of, according to proper time standards and frequency of performance, then management finds it difficult to challenge these figures, if not impossible because they have no other figures to substitute.

Thus, for a measured operation, an arbitrary change in budget requires an equal change in the frequency of job performance, and therefore the quality of service being provided (this assumes, of course, that each worker has been provided a reasonable day's work, is being reasonably trained, properly equipped and supplied, and reasonably supervised).

When management operates with a measured department, when administration calls for a budget cut, management can simply return this "hot potato" to administration by suggesting a "shopping list" of those items which might be eliminated or curtailed. In many cases, on reviewing such a list, management will go back on their decision to make a cut, in view of the results that this would cause.

A second management complaint:

Administration is threatening to turn over this department to contract maintainers.

The contract firms are regularly calling on top management to indicate that the work can be done effectively while saving a great deal of money. They have aggressive, persistent salesmen, along with a number of satisfied customers.

Prevention: Precisely the same prevention is required for this as is required to avoid budget cuts: namely, measurement. The only proper way to compare in-house versus contracted services is through measurement, so that one is talking about "apples versus apples", in order to make a legitimate decision. Surely a contractor can save a lot of money if a lesser degree of service is provided - but so could the in-house operation do precisely the same thing, if that is management's desire.

Administration

Administration, or the top executives of the organization, complain:

I can't get a handle on physical plant management.

Administration feels that they know very little about these operations, and have no real way of determining what is the right amount of money or what is the proper approach to take to the operation of these activities. Because of this, in some cases, arbitrary budget cuts are made in an attempt to stimulate a set of changes that will lead to improved productivity. Obviously, such arbitrary reductions can lead to very expensive or downright disastrous happenings in time.

Prevention: Precisely the same steps that are taken to prevent arbitrary budget cuts, should be taken to provide administration the feeling that they can get "a handle" on this operation. That is, administration should be shown the type of measurement that is being used to determine the operations of this department. This would begin with a survey of the complete facility, leading to a catalog of all items to be maintained, ranging from exterior lighting to pedestal computer area floors, from cooling towers to flower beds, from roof drains to weather stripping.

A measured physical plant operation acts as "Pepto-Bismol" to administrations' upset stomach!

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It will be seen that the measurement of physical plant activities is the item that either prevents the major problems or impinges on all of them. It is the single most important activity that the physical plant director can become engaged in

76TH
ANNUAL MEETING
FOUNDERS
EXHIBITION

Facilities Planning and Construction

Deferred Maintenance and the Self-Evaluation

Henry L. Shelby
Executive Director
Campus Development and Facilities Planning
Tennessee Tecnological University

Over the past several months, APPA has enhanced its reputation significantly, primarily because of the work done toward determining what has not happened to keep the physical plant facilities in top condition. My purpose today is to give some input into how we can use the materials and the publicity that have been generated to cause the decaying condition to be turned around. Now that we have gotten the attention of the chief administrative officers of the universities and colleges, we need to move forward with a plan of action.

Before we become consoled with what others have not done, I invite us to have a self-evaluation. I suggest that we ask ourselves some basic questions. Why have we permitted our campuses to decay? What have we done to make our administrators aware of the conditions? Have we forwarded a formalized evaluation summary of the conditions of each of our facilities? Our publication revealed that one hundred percent of those who responded to the survey stated that they conduct periodic facilities audits but eighty-two percent of these were walk-through surveys. This will not get the story across. Detailed studies must be made and reports must be forwarded in order to make an impression on those who control the money.

The answers to most of our questions are generally: Not enough staff, not enough money, or not enough staff and money. Probably for these reasons we have resolved that we have done all that we can since we have informed our boss of the conditions.

There is one prevailing condition throughout the physical plant areas of our world that in my judgment has caused most of the conditions and that is that most physical plant organizations report directly to the chief financial officer whom we perceive to be more interested in balancing the

books than in correcting conditions. Whether this assumption on our part is valid is really not the issue. The truth is that we have not equipped our administrators with the facts needed to correct our situation. For far too long we have allowed our story to fall on deaf ears. I suggest that when we go back home we devise a method to fit our situation that will tell the story so that it will be heard.

In the mid sixties I devised such a plan that worked for our university and has become a state-wide plan. I am fully aware that many cannot be as aggressive as I was and as I propose because to do so may be suicidal. You should know that before I became employed in physical plant work eighteen years ago, I worked in manufacturing management for more than twenty years. My early training was that a quality product must be produced on time at a cost not to exceed the estimate and that nothing, but nothing, was to stand in the way of keeping that from happening. Be it known to you here and now that I am not proposing that any of you do as I did, but I am urging that each of you devise your own plan of action.

When I first started to work for the university, many facilities had been neglected. For instance, it was difficult to find a section of any roof that did not leak. It was next to impossible to keep the mechanical and electrical systems working properly. Everything had been patched for so long that there were patches on patches and for about three or four years we continued to add more patches and to allow everything to go backward rather than forward. There were items in each of the buildings that did not meet life safety codes in addition to the negative appearance of many of the facilities.

We determined that something must be done to get administrators to better understand the situation and that it must be conveyed that this was not just a problem of the physical plant but was a problem for the entire university, and in our case for state government since we are a state-supported institution. Since everyone could relate to leaky roofs, we began by evaluating all of the roofs, both the good and the bad. We were fortunate in that we were able to get a reputable roofing company to assist us at no charge. We then listed in order of need all roof ratings showing those that needed immediate attention all the way through to those that had very little need. Whether or not the ratings were totally accurate is really not that important. What was important was that the ratings had a relative relationship. That is, the spectrum ran from the worst to the best. The first breakthrough that resulted from this was an agreement to allow the bidding of roof repair work on a yearly basis. It was discovered that the larger firms were willing to do the small jobs if they had an opportunity to do larger jobs. That type bidding based on an hourly rate for labor and an agreement to markup on materials has been in effect for many years and has been expanded to cover all trades. Those who controlled the purse strings said that such a contract would not be allowed, but it was.

From this beginning, evaluations have been conducted on all elements in the buildings and as stated earlier have become a state-wide procedure. The ratings derived from these evaluations are the sole basis for the request for funds from state appropriations. We finally believe that we have become number one in something in our state.

In my judgment, now is the time to begin to defuse the ticking time bomb. It is time to move the responsibility for funds outside the scope of the physical plant. With the rapid passing of time, many may have forgotten that the buildings that were constructed during the rapid growth of most universities was thirty plus years ago. To quote from our publication The Decaying American Campus, "The facility decay issue is not new. The problem has been cited by numerous authors and associations during the past ten years." In spite of these efforts, the problems have accelerated. What I want to say most is that it is time for us, the real pros, to move in with the story since we are the only ones qualified to tell the story and then correct it.

Our task will be difficult since so much of the needs apply to things that are not readily noticeable. The appropriation of funds for each college and university becomes more difficult each year not only because our facilities are getting older but also because new government regulations continue to be added. Benefactors are not as interested in giving funds to update mechanical rooms, replace roofs, or remove asbestos as they are for giving to athletics, building a new fountain, or constructing a facility that will bear their name. The chief administrator is not excited about raising student fees to correct our problems.

The facts remain, however, that the dilemma that we are in will take money, lots of money. We must evaluate our facilities, price our findings, and let it be known. In short, we must provide leadership, and we need to provide it now. No member of the legislature, in the case of state-supported institutions, nor any member of the Board of Trustees, in the case or private institutions, should be allowed to look at future funding without knowing the cost to bring all the facilities up to an approved standard. We are the ones to do it.

Neely

Predicting Maintenance Resources for New and Existing Facilities

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ABSTRACT

The United States Department of the Army faces a major challenge in obtaining accurate life-cycle resource information. In an effort to improve life-cycle costing within the planning, design, and maintenance areas, the U.S. Construction Engineering Research Laboratory (USA-CERL) located in Champaign, IL, has been conducting a research program for several years.

USA-CERL's research has provided the following products: (1) designer handbooks for life-cycle maintenance resources cost analysis, (2) historical unit cost factors by facility use categories, and (3) computer prediction models on three different computer hardware configurations. Several installations within the Army and the Army Reserves are using the computer systems in the United States and Germany. In addition, other Army researchers are applying the results of this research.

This paper addresses the use of life-cycle cost engineering within the Army, prediction models available, facility description methods, model applications, computer systems available, and benefits. Large portions of the research were performed by Pennsylvania State University undergraduates, graduates, faculty, and staff. The results of this research will be incorporated into the education system.

LIFE-CYCLE COST APPLICATIONS

The Army calculates life-cycle cost in three phases during the facility's life:

1. In the planning phase, planners are required to state the estimated life-cycle costs for new facilities. If a new facility replaces existing facilities, the actual life-cycle costs for the existing facilities must also be reported.

2. In the design phase, designers must select components based on the lowest allowable life-cycle cost. At present, most designers use manual application tables. On large projects, the designer applies an existing life-cycle costing program using specific present worth calculation procedures.

3. During the maintenance phase, once each year an annual work plan, budget, and long-range resource plan are produced.

Different procedures are applied in the three phases. One purpose of this research is to develop a single, uniform method to be applied in all three phases.

PREDICTION MODELS AVAILABLE

Five prediction model types are available. Four have been computerized in USA-CERL's research program, whereas one model is intended for manual application. Each model type is described below.

Average Actual Expenditures

The Army maintains actual expenditure data on a unit cost basis by the current facility use. For example, hospital historical expenditures are recorded in dollars per square foot of floor area. The past 5 years of historical data are adjusted to a base year and then averaged. This data is published by current facility use for planning and programming applications; it is available for each installation, Major Command (MACOM), and total Army, and has been computerized for application at all levels of management. This method produces one total cost figure which is identical for every year.

The model considers two items: (1) current facility use and (2) floor area. The current facility use is applied to locate the historical unit cost per square foot of floor area. This unit cost is multiplied by the square feet to obtain a total cost. The model is for calendar year prediction.

This model can be applied to both individual facility data and organizational summary data. Summary data can be formed by comparing all facilities of one type (e.g., hospitals) built in the same year (e.g., 1962). The floor areas of all such facilities are added together to form one facility group.

Yearly Resource Prediction

Three data items are available for every Army facility: (1) current facility use, (2) construction year, and (3) unit of measure, such as floor area for buildings. This prediction model uses the three data items coupled with average Army resource data by facility current use. The average resource data were developed from a detailed analysis of tasks that should have been performed to keep actual facilities at several test installations in a standard operating condition. The resource data includes labor hours, equipment hours, and Washington, DC, material costs. The data items are stored by facility age (e.g., the labor hours, equipment hours, and material cost for a hospital facilities that are 24, 44, and 65 years old).

The computer model applies the actual installation labor and equipment costs expressed in dollars per work hour. The Army publishes a cost adjustment factor to transfer the Washington, DC, costs to the actual installation. The system transforms age resources to calendar year resources by subtracting the construction year from the calendar year. The following resource information is calculated for each calendar year: (1) labor hours, (2) equipment hours, (3) labor costs, (4) material costs, (5) equipment costs, and (6) total costs.

The resource requirements differ for each year, depending on the actual work that should be performed. Requirements may fluctuate greatly from year to year for an actual facility. This model is a calendar-based year prediction approach.

The yearly resource prediction model can be applied to both individual facility data and organizational summary data. Summary data can be formed by combining all facilities of one type (e.g., hospitals) built in the same year (e.g., 1962). The floor areas of all such facilities are added together to represent one facility group.

Facility Component Description Methods

These models are designed for calendar year prediction. A facility can be described in more detail than the three basic data elements. The following three examples are given to demonstrate the possibilities.

1. Describe all components; calculate all tasks. The user can describe a facility in any level of detail by listing construction components (e.g., maple plank floors). The more components defined, the more accurate the facility description. For every construction component, a list of tasks that must be performed during the complete life cycle is developed. Each task has associated labor, material, equipment, frequency, and trade information. The computer calculates resources for every task and then sums all tasks into a component summary. These summaries are combined into subsystem totals; subsystem totals to system totals; and finally, system totals to total facility resources.

2. Describe all components; calculate major cost tasks. Each task is classified as either a major or a minor cost task. Major cost tasks are

defined as all replacement tasks and other tasks that cost more than half of the total replacement task cost. All minor cost tasks are combined into one summary record. The computer calculates each individual major cost task and uses the summary record instead of the individual minor cost tasks.

3. Describe high-cost systems only; use summary data for other components. The computer system contains a system resource summary based on the detailed individual facility research described previously. The modeler may elect to define all architectural finishes such as floor, ceiling, and wall components, but can default to summary data for electrical, plumbing, and mechanical systems. The computer system calculates the tasks for the components and uses a system summary record for the electrical, plumbing, and mechanical systems.

This option allows a facility to be defined in any way and at any level of detail. Average data will be applied to cover systems not defined by components.

Facility Age Resource Predictions

This model will use the facility component description to perform calculations by facility age for any age range from 1 year to a maximum of 120 years. This model is used to determine the average resources for use within the calendar year models described above.

Life-Cycle Cost Tables for Manual and Computer Applications

A set of present worth table is published for each trade or discipline. The designer reviews the data before selecting components for a design.

The fastest and least labor-intensive application is for the designer to apply the 25-year present worth unit cost for the Military District of Washington, DC, by quickly reviewing this column and making a selection. When a more accurate calculation is desired, the designer applies the installations's actual labor, material, and equipment resource rates to the labor, material, and equipment resources in the table.

The second section of this table provides resource information for input to life cycle costing computer programs that perform present worth factoring within the program. An equivalent uniform resource requirement is given to cover all minor cost tasks. All major cost tasks are listed individually.

COMPUTER SYSTEMS

Models are implemented on three computer hardware configurations. The actual data and yearly resource models are implemented on all three configurations. The individual facility component models run only on the third configuration.

The first configuration is an IBM worldwide timesharing mainframe computer. The software is written in the NOMAD II relational database.

The second configuration consists of a basic DOS personal computer (PC) with a minimum of 10 megabytes of disk storage. The software is written in FORTRAN.

The third configuration is an extended DOS IBM-AT PC with a mathematics coprocessor chip, 3 megabytes of random access memory (RAM), and from 140 to 620 megabytes of internal storage. The software is also written in FORTRAN. To make efficient use of storage, in-line compression routines have been applied. All calculations are performed in RAM to increase processing speed. The systems still require additional processing and storage reductions.

SYSTEM APPLICATION

The extended system is being used by four military installations in the United States and two in West Germany. Several headquarters organizations within the Army are applying the extended system to (1) perform long-range stationing impacts, (2) produce planning and programming requirements for Army units, and (3) calculate maintenance resources for very old, historic, family housing quarters.

INSTALLATION CAPABILITIES

An Army installation is much like a small city. Thus, the system as configured can be applied by any organization that maintains facilities such as city governments, large corporations, large real estate agencies, and universities.

The maintainer keeps a complete corporate maintenance database in one location. Congressional, MACOM, and headquarters inquiries related to maintenance planning and programming activities are answered quickly while the inquirer is on the telephone. Headquarters and MACOM usage will eliminate many of the current inquiries to installation personnel. In addition, the installation can more accurately predict its future maintenance resource requirements.

Facility information related to geographic location on the installation, current facility use, number of facilities identical to this facility, travel time from shop to facility, organizations performing the work, and effect of the occupant and weather conditions on the facility can be kept together in the same database.

Records can be kept to show the last time a major cost task was performed and the next time that task is scheduled. Inspection and maintenance notes can be kept on each task. The notes can be used to record the exact color and grade of materials used, special problems encountered during inspections, and similar information. Such computerized records eliminate the need for separate paper files such as painting and floor refinishing schedules. They also replace separate paper files now being kept on each facility within each shop. The installation has an automatic record of when work was performed and when it should be scheduled.

Resources for facilities that are being used for the same purpose or functional use can be combined into one total resource summary. The resource prediction summaries can be displayed in either bar chart or tabular format. The installation can use this information to help commanders at all management levels understand the actual resource requirements of an installation. Predicted resources for a facility, group of facilities, and an installation are not constant; some years require fewer resources than others. One or two years may require an extremely large number of resources due to major component replacements. This installation-generated summary information can be passed to the MACOM and eventually included in the President's budget submitted to Congress.

An ordered list of the high-cost items during each year can be listed both by component (e.g., carpet) and task (e.g., replace carpet). These reports allow the installation to pinpoint the high-cost items during a specific year or time period and check to ensure that all supporting documentation has been prepared. In this way, the installation can identify the high-impact areas that should be investigated in an effort to reduce resource requirements.

Questions such as, "What are the installation's predicted resource requirements for shingle roof replacement on administration facilities in 1993" can be answered quickly by displaying the summary information on the screen. This feature saves the installation hours of manual data collection, analysis, and special report generation. Individual facilities that need roof replacement can also be listed. This list can serve as the basic checklist for inspection of facilities to be included in the annual work plan. It can also be used to write the statement of work for contracts and produce the Government cost estimate.

TOP-LEVEL MANAGEMENT PLANNING CAPABILITIES

A MACOM controls several installations (cities) and could be considered equivalent to a large university consisting of many campuses or a large corporation controlling many plants. The MACOMs provide planning, programming, review, and approval functions over the installations.

Headquarters, Department of the Army (HQDA) controls all MACOMs. HQDA can receive summary resource prediction information from the MACOMs and combine the MACOM summaries into an Army summary. The same report, display, and query functions available to the MACOM and installation levels are accessible to HQDA.

MACOMs can display summary resource prediction information for both their own organization and each individual installation under their management. This summary information of the MACOM's needs can be given to HQDA. The high-cost items within the MACOM during each year can be obtained in descending order of costs by both component and task in the same format as shown in Figure 5. The MACOM can therefore focus its limited management resources on the high-cost-impact tasks. Inquiries such as, "What are the MACOM's predicted resource requirements for shingle roof replacement on administration facilities" can be answered quickly by displaying the information on the screen. This capability will reduce the manpower required to determine answers to such questions.

TASK DATABASE DEVELOPMENT

The task database forms the basis for the second, third, and fourth models described above. A task is defined as work performed on a component by one trade.

A component task database has been developed to cover all material components used in Army construction. This database addresses most of the material components used in normal construction throughout the United States and Germany. This information was developed by professionals in each trade. All data was reviewed by other professionals in both private and Government agencies. The first step in the development process was to identify all construction components. For each component, a list of all tasks that would be performed over the component's life cycle was then developed. Task information was next developed for each task. Three frequencies of occurrence were developed. The earliest time a task would be performed is given as the high frequency. The average time is given next, followed by the latest possible time a task would be performed.

Each task is divided into subtasks and the labor hours and material cost to perform the subtask are given. All labor hours were either taken from or developed by the procedures in the Department of Defense Engineered Performance Standard Manuals. Material costs were taken directly from the U.S. Army Corps of Engineers Cost Estimating System Manuals for the Washington, DC, area. The indirect labor hours to cover job planning, material collection, breaks, and related information were added as required by the Engineered Performance Standards Manuals to produce a total requirement. The travel time between the shop and the facility is added during the calculation of each individual facility.

BENEFITS

The Army now has a consistent, uniform method for determining maintenance requirements for all of its organizations. Installations have a computerized corporate maintenance database that can be used for numerous functions. This database will not vanish when personnel leave.

The system provides an automated tool to help predict future resource requirements based on the condition of the installation's facilities. Installation, MACOM, and HQDA can obtain answers to questions with little impact on personnel resources.

If the installation desires to contract the maintenance of all facilities, the system provides cost estimates and realistic task and component quantities. This function is very important when the installation has no knowledgeable in-house workforce to estimate this information.

Shop schedules can be kept in the system, eliminating the need for paper files that can be lost. The system provides the installation with future contract requirements so that the manpower to write, award, and manage the contracts can be obtained.

The Army can use this system to perform its maintenance planning and programming functions more efficiently, effectively, and consistently based on the actual facility needs.

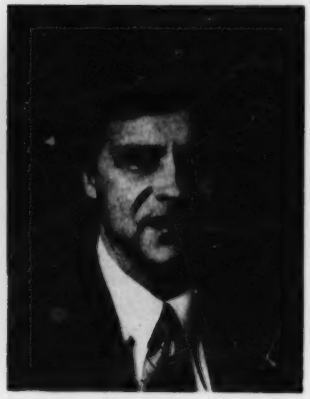
FUNCTIONAL APPLICATIONS

Portions of this research has been performed by graduate students as part of their research program towards a master's degree. Undergraduate students work during the summer at installations setting up the installation's facility data base. This has provided the students with the opportunity to learn the complexity of Army facilities first hand. Plans are currently underway to incorporate life cycle costing procedures into the main stream education program.

POTENTIAL APPLICATIONS

This system is not limited to applications in the U.S. military structure. Universities, cities, companies, and government agencies located in any developed country can apply this system to predict life-cycle requirements during planning, design, and maintenance management. This information can be integrated into both undergraduate and graduate level design courses.

Brandt



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Design Approaches to the Special Challenges of Academic Facilities

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In the planning, design, and construction of new academic facilities or the renovation of existing structures, facilities managers must provide a bridge between the constituencies they serve and the architects they hire. In our talk, we'll attempt to outline some of the things that we as architects have learned about the special challenges presented by academic facilities. We hope you'll learn more about how the design process works within the academic context. By detailing the kinds of issues that concern us as architects, we hope to show you how to work most effectively with us. By using your intimate understanding of the way your community functions to shape decision-making, you'll be able to exploit our skills to the maximum and achieve an efficient, fluid process. Our talk will examine two types of challenges: those connected with the decision-making process itself and those that have to do with the actual programming and design issues presented by academic facilities. Several key considerations will be highlighted by reference to projects we've recently worked on.

Understanding the Decision-Making Process

As facilities managers know well, the decision-making process by which academic facilities--whether brand-new facilities or large-scale renovations--are planned, programmed, and designed can present a very thorny path, strewn with a number of obstacles. It's therefore of primary importance that architects and facilities managers work together to determine early on just what the decision-making trail will be. Having even a general idea of the kind of terrain you face as the decision-making process gets underway will give you some tools for smoothing the way and expediting progress as you go along.

The academic decision-making process may, of course, take any of a number of forms. Perhaps the first key issue you will face will be to determine the particular decision-making method your institution ordinarily employs. Two

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extremes--one simple, the other potentially quite complex--are presented below. The process that prevails in your own institution probably lies near one or the other of these extremes. Since decision-making in academia is more often collegial than not, it's also probable that some of the difficulties, mentioned below, that attach themselves to democratic decision-making will emerge when your institution plans, designs, and builds new facilities.

When the decision-making process is a simple one, the committee responsible for making decisions is usually led by one very strong personality or by someone whose office carries enough clout that other committee members will defer to his or her authority. This has been the case, for example, in HLW's design of two new laboratories for the University of Mississippi, whose chancellor gives a great deal of attention to all new building projects and is keenly interested in campus architecture. The authority of his office, coupled with the enthusiasm he brings to the task, exercises a major influence on facility design while ensuring that the process moves as smoothly and swiftly as possible.

That kind of situation is, however, rare. More commonly, decision making results from the democratic activity of a committee. A committee approach can be a positive one, but it must be carefully directed. Architects and facilities managers need to be aware of the multitude of factors that might complicate the process, bog it down, and produce frustrating delays. In such circumstances, there are ways to promote participation by various constituencies without disrupting progress.

Democratic Decision-Making Committees. Committees have enormous potential as forums for the creative interchange of ideas, but facilities managers and architects must work together to develop a game plan to assist committees in realizing this potential and to fend off the possibility that the forum might devolve into an arena of competing agendas. Decision-making committees are often loose confederations of faculty and other facility users, and hence are rarely cohesive at the start of the decision-making process. Even when antagonism doesn't mar the process, this lack of cohesion, coupled with the possibility that the committee may include several strong-willed proponents of different agendas, may lead to the process's becoming much too drawn-out. If the process is protracted, the limits of the program, the schedule, and the budget may be severely tested. In one recent HLW academic project, competition among agendas succeeded in causing a delay of two years while issues of site and territory ("Which dean's building is it?") were sorted out.

Such extravagant delays serve no one's interest. To avoid them, it's essential, insofar as it's possible, for the architectural team to assume a leadership role by laying out the parameters of the interactive process. The process should be designed so that options are sequentially presented and narrowed down. In a nutshell, the procedure works like this:

1. A thorough effort at the outset will establish the project mandate, goals, and constraints, providing the context in which the entire team can then function. This necessary step will foster cohesion right from the process's beginning.

2. Preliminary programming should then focus on defining basic functions and needs. At this early stage, committee members should focus on what they do --not on their design ideas--to allow the architect to take the lead in delineating the range of possible directions for design to take.

3. Then, designers and programmers put forward their understanding of the project and present a number of general options for the committee to review and respond to.

4. After these responses have been tallied and examined, the architectural team surveys the next level of detail in those options that were selected for further consideration and develops the next statement for presentation to the committee.

5. This feedback loop is repeated until the appropriate level of programming/design refinement has been achieved.

This sort of procedure ensures that a committee won't waste time by retracing steps it has already taken.

Constrained Schedules. Scheduling, too, can present a formidable hurdle. In designing academic facilities, scheduling isn't a single process that depends merely on how quickly the architect can work. There are a number of common scheduling problems that can provide some unpleasant surprises. Why is it important to recognize these constraints in a project's earliest stages?

An architect who has little direct experience working in the academic context may tend to underestimate the amount of review time required by academic clients. This can impair the architect's ability to staff properly or even to evaluate his or her ability to meet your schedule at all. It's vital, therefore, that you, the facilities manager, sit down and think about how your process works--in a detailed way--so that you can let the architect know as much as possible about your institutional culture, the personalities who will be involved, and the recent history of building projects at your campus. You'll also want to think about how the project you're currently facing may differ from past projects. Is it a different kind of project? Has the cast of players changed? You'll need to be a bit of a prophet as well as a historian.

The problems that may afflict scheduling are multiple. First, there's the fact that the individual schedules of key players on the decision-making team may conflict with academic commitments that, of course, take precedence over committee work. Milestone dates--especially in the case of interior renovations to existing, occupied buildings--are often geared toward the academic year. Semester breaks, holidays, vacations, the period of intense activity that occurs at semester's end--and the fact that meeting-schedules must fit into this pattern--can conspire to slow the process down or speed it up artificially. The fact that the construction schedule is often very tight and limited to the summer months, beside introducing difficulties of its own, can have an impact on decision-making schedules. There isn't any grace period at the end of the academic year, meaning that final decisions might be made too hurriedly in order to accommodate the construction schedule's demands or, more likely, that because enough committee time can't be squeezed into those last

weeks, final decisions are postponed and the start of construction put off--for another year! Such problems are not insurmountable, however, especially when designers and decision makers are well informed about the kinds of constraints they face. A clearly articulated, accelerated design schedule and a correspondingly straightforward design approach saved the day in the renovation projects HLW recently performed for science and journalism facilities at New York University, where construction was limited to the summer months.

Recognizing the Impact of Project Funding on Design

Funding from Outside Sources. When funding originates from an outside source, as is more often than not the case with new academic facilities, the budget is likely to be predetermined and strictly fixed, and when a budget is fixed, the design must be able to accommodate program changes that can bring the project within budget limitations. That said, it's important to add what might seem a contradictory note: that programming and design must be flexible enough to respond to contingencies like the sudden infusion of new monies or the sudden loss of gifts or grants that had been expected. (If programming is an unfamiliar word, think of it as the name architects give to the process whereby user needs are determined and then integrated with design goals to achieve the best interaction among a building's components and the best fit between space use and design.) Facilities managers must equip themselves with an understanding of just what the essential, or core, functions of a new facility will be, so that, when and if cuts come, you know ahead of time what can and can't be eliminated.

The Need for Clear Understanding of Budget. The budgeting situation is often made more difficult for the architectural/engineering team in charge of the project by the lack of consideration or understanding of budgetary constraints that's sometimes displayed by members of the decision-making committee. Two common pitfalls are a lack of understanding of the relationship of space to budget and of the difference between project and construction costs.

First, the relation of net (i.e., usable) square feet to gross square feet must be carefully defined. The team must be informed that construction costs will be incurred for gross square feet--that is, for every square foot a contractor builds. Often, the preliminary plans that an institution draws up for a facility are cast in terms of net square feet, and the gross square footage that will result from a given set of usable space requirements is greatly underestimated. The facilities manager, working with the architect, must educate the committee about the actual net-to-gross ratio a facility can be expected to have. (And be prepared for expressions of shock from some committee members--who won't have had any idea about how much of a building's total space will be required for corridors, elevators, stairwells, and so on!) Our recommendation is that an architect be involved as early as the preparation of funding proposals to confirm the space estimates and avoid disappointments later.

Second, it's essential that everyone realize that the cost of the building alone (i.e., the construction, or building, cost, which it's the architect's job to estimate) is only a portion of the total project cost, which includes expenses such as financing, site acquisition, furnishings, administrative fees,

professional fees, and relocation costs. Oftentimes architects have only a partial understanding of total project budget, and, for their part, decision-makers don't clearly understand that the estimate an architect quotes is for building costs alone. Obviously, the key to controlling costs and preventing disastrous errors in estimation is clear communication between the participants --and facilities managers can and should play a major role in fostering the kind of mutual education that makes for a good working relationship between decision-making and design team members.

A system of checks to ensure that budget limitations are being met should be built into the programming and design process as it evolves. For instance, an initial budget check should occur as early as the end of programming. This sort of close monitoring at every step will keep you from having to slash large chunks off the project in its final stages.

Planning and Designing for Future costs. Although the long-term costs of operating and maintaining a facility are not part of the initial project budget, such costs should have a definite effect on how a facility is designed. As physical plant administrators are painfully aware, operations and maintenance staffs for academic facilities are usually minuscule in relation to the size of the facilities they care for. In an era when maintenance costs rise inexorably and when the desire for new facilities is so often outweighed by the pressing need to repair older buildings, it is imperative that new facilities not add unreasonably to an institution's already strained maintenance budget.

Architectural and engineering design must guarantee that facilities be simple and economical to run and maintain--in other words, that they be as "maintenance free" as possible. This is an especially challenging job in the case of academic facilities because of the brutal wear-and-tear such facilities are usually subjected to. Designers can provide facilities managers with essential help in preparing estimates of life-cycle costs that a building will incur over time. Figuring such long-term costs into a building's design can make important differences concerning, for example, the type or quality of the mechanical systems a building will employ.

Dealing with the Magnitude of Programming Issues

The task of programming an academic facility presents space planners with a number of challenges that, although they are not completely different from the issues confronted in programming any facility in which work goes on, are heightened or exacerbated in the case of academic facilities.

Strategies for Achieving Flexibility. Programming must be responsive to a variety of uncertainties, both present and future. The combined impact of these uncertainties dictates that facilities be programmed in an extremely adaptable way. Programming must provide the flexibility a facility will need to adjust to curricular changes, changes in research priorities (which, these days, can take place very rapidly), and unexpected changes in funding.

Programmers can help ensure that the needed flexibility is achieved by employing a few related strategies. First, it's important to develop a limited

number of space standards for classrooms, offices, labs, and other spaces. This can involve some work since there aren't currently accepted industry-wide "standards" for programming academic facilities. Instead of standards, institutions often depend upon customary, institution-specific ways of doing things that have gradually come into being over the course of a school's history or that function in an ad-hoc manner, project by project, through the particular desires or procedures of a given department or set of individuals. While these customs have to be reckoned with, facilities managers and architects should together make a case for the development of standards.

"Standards" is a scary word for academics, since it conjures images of regimentation and restrictions on freedom of working style. In fact, the opposite is true. If sensitively developed and intelligently deployed, standards permit a degree of flexibility that is essential as curricular and research priorities shift. Standards are advantageous simply because you won't have to redo a building every time people or departments are moved around. And there are ways to accommodate personalization within an effective standards program.

If possible, standards should be set at a campus-wide level to truly maximize flexibility. Remember that buildings will long outlive the occupancies for which they were originally programmed. More commonality throughout the campus equals more flexibility. Your ability to set campus-wide standards will of course depend on the extensiveness of your institution's current program of new building and renovation. If a number of new facilities have recently been constructed, you may want to include a post-occupancy evaluation of recent buildings (to determine the possibilities for building-to-building standardization) in the contract you draw up with the architect.

Employing a modular planning scheme means that classrooms, labs, and offices are sized and proportioned to accommodate several furniture and equipment layout options, which goes a long way toward ensuring a modicum, at least, of flexibility. Most important to remember is that space must be programmed in as <u>generic</u> a way as possible: that is, only very limited customization of labs and offices can be permitted, although the standards that are used must--again, in a limited way--allow for differences in function and working styles.

<u>Privacy versus Interaction.</u> The programmer's duty to achieve a good balance between communication, on the one hand, and privacy needs, on the other, provides a perfect example of how the issues confronted in space planning any facility are amplified in the case of an academic facility. Balancing interaction and separation is an important consideration in planning any workplace, but in programming academic buildings one must sometimes jockey an incredible number of competing constituencies. Simply listing some of these relationships will give an idea of how complex the challenge can be:

- Students/faculty
- Teaching faculty/research faculty
- Graduate students/undergraduates
- Faculty/administration
- Office personnel/lab personnel
- Technicians/researchers

To this picture must be added the fact that each group has, within itself, competing needs for peer interaction and for privacy. Of course, it's rarely the case that every single one of these constituencies will be represented in one facility (although it's conceivable that that could happen), but it's easy to imagine facilities where many or most of the groups listed above would be represented. In the renovations HLW performed for NYU, for example, the university demanded that the new facilities do something to actively promote more serendipitous interaction among faculty, students, and administration--a tall order given the less-than-harmonious relations that prevailed between these groups. How can programming keep the situation from going haywire?

Adjacencies should be determined by discussing specific institutional goals and not by simply reiterating preconceived preferences for group adjacencies. Programmers have to make sure that such goals are clearly understood, both by themselves and by those who will occupy the facility. In the effort to promote interaction while ensuring privacy, space planners must also pay special attention to circulation spaces. Here again, we see how a programming issue that would be encountered in any facility is intensified in an academic facility, where circulation schemes must take into account the surges in volume that occur at regular intervals throughout the day to guard against the disruption that can be caused by the commotion that accompanies peak flows.

The work that goes on in an academic facility is highly interactive, and so spaces in which people gather to communicate can either be defined spontaneously or planned. The programmer must be especially sensitive to this, striving to incorporate "nodes," or interaction places, into the program in a way that anticipates how people will behave. Designating certain spaces as lounges may be appropriate, but other, informal interaction spaces (mailrooms, photocopiers rooms, kitchens, etc.) must also figure in a program. The point to stress is that interaction must be encouraged in appropriate venues while being carefully controlled throughout the program as a whole.

Decisions made in programming must be consistently followed through in design. When a design is closely related to a program, the image that's achieved will be more than just "good looking": it will relate to the institutional culture in a number of fundamental ways.

Identifying and Creating the Desired Image

Image is almost always important in academic facility design. Institutions rightly expect that the creation of a new image will have significant positive impact on the recruitment of faculty and students. The kind of image sought will vary greatly from case to case, however, and the creation of a particular image will involve the designer in responding to a host of considerations. The foremost of these is probably the personality, or character, of the institution as it already stands. This existing identity may have a positive or a negative valuation: that is, a new building might be expected to reinforce that identity or, oppositely, to make a significant contribution toward altering it.

Innovative Images. For example, decision makers may conclude that a new building's design should make a statement about how progressive and innovative their institution is (or wants to be). Universities are often motivated to--and can afford to--go further in pursuit of an innovative image than are many corporations, which often prefer images that are consistent and "dependable." Or an innovative, striking design may simply "fit" better in a campus that amounts to an "architectural museum" of strong, individual design solutions. In the context of a campus dominated by traditional architecture, a visibly high-tech building might be seen as a vehicle for changing the institution's image, but if this is the direction chosen, designers must tread very carefully a very narrow line, making certain that the new facility doesn't "insult" the architecture that surrounds it while also guarding against too demure an approach, which might result in the new building's simply being swallowed up (or made to look ridiculous) by its predecessors.

Designers must pay close attention to how a campus has evolved historically. Relatively few campuses--perhaps none--have been absolutely static, design-wise, over the course of time. The designer must be sensitive to these historical changes in emphasis and perhaps search for a starting point in those of a campus's more recent buildings that have gained acceptance while breaking new aesthetic ground.

Specific limitations on design may follow from the fact that funding comes from an outside source or sources. If funding is supplied by a private donor, it's often true that the donor's wishes--especially as regards image and aesthetic preferences--must be considered and respected. This must be understood from the outset, lest the donor exercise an unanticipated veto power after major design decisions have been made. In this same connection, "star" faculty, who may be responsible for building an institution's reputation or who may have been instrumental in procuring grants or other outside funding, may exert (or wish to exert) substantial power to decide how a facility will look and/or how it is programmed. This factor, too, needs to be kept in mind and communicated to all concerned from the very beginning of the design process.

Also, when funds are procured through grants from federal or state governments, specific contracting procedures and other regulations (as well as governmental goals in funding the new facility) must be obeyed, and these may have significant impact on programming and design.

Shared Aesthetic Values and User Acceptance. Basically, design must be responsive to an academic community's shared aesthetic values. This reality brings us to the key to an academic facility's success: acceptance by its users. It's important to point out that "users" includes potential as well as current users. New facilities are often expected to make a positive difference in an institution's ability to attract students and recruit new faculty.

Interior Design and Special Design Issues. Designers must acknowledge the fact that, to gain acceptance by its users, a new facility must be perceived as measurably adding to an institution's quality of life. Decision makers, programmers, and interior designers must remember, for example, that in an academic facility amenities aren't merely "extras" that can be tacked on without much consideration as to their quality or placement. Amenities are

extremely important in a workplace where profit and "career" (at least in the corporate sense) aren't the overriding motivations. Amenities are a collateral benefit in the academic community--a "perk," so to speak.

User acceptance will also be fostered if interior designers, working closely with programmers, acknowledge the strength of the proprietary instinct--the sense of "territory," or "turf"--among staff. Programming and interior design offend this instinct at their peril, although accommodating it must be continually balanced against other project concerns.

The list of special design challenges encountered in academic facilities is potentially quite long. There are, for example, numerous challenges that have to do with the environment as a whole. Under this rubric we can list, first, the special durability needs mentioned earlier. Special concerns regarding lighting, acoustics, and air quality must be carefully addressed. Also, security issues are particularly complex in academic institutions, and designers must strive to discover workable responses to contradictory desires for, say, security against vandalism, on the one hand, and free and open access (usually including off-time access), on the other.

Conclusion

All of the ingredients that will go into making decisions regarding program and design must be understood and, to the fullest extent possible, brought together so that a reasonable product will result from a reasonable decision-making process. Facilities managers should exercise a key role in helping the architect to "educate the educators" who comprise the decision-making committee and in letting the architect in on all the variables that affect design. That is, the degree to which the facilities manager assumes the leadership and liaison roles we've outlined will have a very definite impact on both process and design. Let's not forget that the special challenges presented by academic facilities are not only "problems" but also carry the potential for creating special opportunities to design buildings that are flexible, functional, and innovative in design. We hope that we've been able to communicate the degree to which architects are dependent upon facilities managers for the guidance and interaction so very essential to success.

Turner

Construction Cost Management in the Public Sector

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Introduction

While inflation today is not the problem it was in the 70's, increasingly complicated projects continue to add to the Owner's frustrations of the project delivery process. Due to changing technology and the ever-increasing budgetary constraints we all experience, the successful management of project costs is typically the most persistent and challenging aspect of any facility development program.

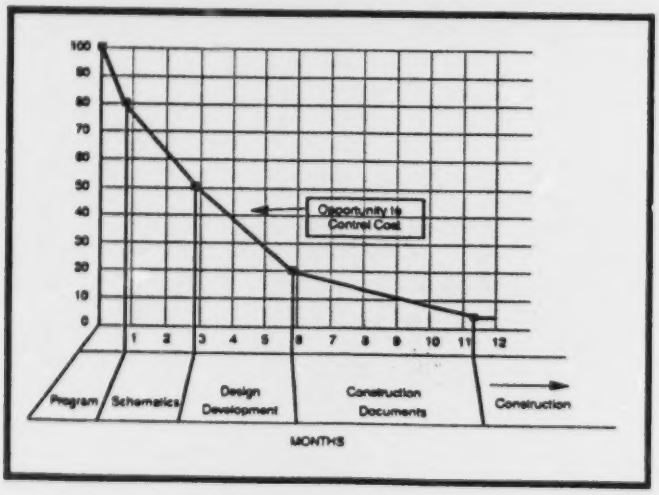
This presentation will deal with the general philosophy, systems, controls and procedures that have been successful in delivering numerous projects to the eventual user with the agreed upon scope; with the agreed upon quality; within the agreed upon timeframe; and perhaps most importantly, within the agreed upon budget parameters. Achieving these goals, particularly in the public sector environment, in a successful, yet painless process, is the ultimate goal of any owner or administrator.

Importance of Early Cost Control

Many sophisticated Owners and professional consultants are of the opinion that optimum project success is determined long before construction begins - in the feasibility, planning and design stages of projects. The importance of early cost control cannot be emphasized enough.

The following chart illustrates in general, the opportunity to control costs during the key phases of a project. More specifically, it shows that at the beginning of a facility development program, the owner's opportunity to control project costs is 100 percent. Immediately after the Program Phase, the earliest and typically shortest phase of a project, the opportunity to control costs is reduced to 80 percent. In other words, decisions that have been made based upon preliminary and narrative information, have begun to commit specific dollars towards the accomplishment of such goals or parameters. Immediately thereafter, the Schematic Design Phase is completed in a relatively short period of time, thereby further decreasing the opportunity to control costs to approximately 50 percent, again short of going back and redesigning. This process continues all the way through completion of construction documents, at which time the owner's opportunity to control costs, without re-designing (which takes time and money), is reduced to as low as five percent.

The significance of such an exhibit is to help illustrate the discipline or appreciation for early identification of project costs, before a great deal of design takes place and the project team decides, to the dismay of facility users and administration, that it is time to stop and redesign or rethink certain decisions in an effort to "trim costs" or "reduce scope".



Difference Between Cost Estimating and Cost Management

In this challenging and ever-changing industry, it is our professional opinion that a great difference exists between what is typically referred to as cost estimating versus the practicing of cost management.

Cost Estimating is most widely known as the periodic process of taking a set of design documents at the completion of a particular design phase and preparing a estimate of the costs based upon such information derived or assumed from the documents. This information is then typically transferred back to the Owner to be compared against the budget.

Cost Management on the other hand is the establishment of realistic capital costs of construction projects at the earliest stage and the subsequent continual monitoring and financial management of the planning and design process. It embodies detailed cost planning and cost control services to ensure that construction projects are bid, documented and completed within the pre-agreed cost framework and in the most economical manner consistent with program requirements and aesthetic considerations.

The cost management approach is the interactive and continual process of working with the owner, user, design professional and special consultants as a close-knit team to provide input as the facility is being designed. The converse of this approach is to be kept in a vacuum and asked to periodically provide an estimate at the completion of a particular design phase. The cost management approach allows the cost manager to fully understand the project needs and to be able to maximize his involvement and ensure that the project receives accurate and timely input and as a result, the maximum scope for the dollar.

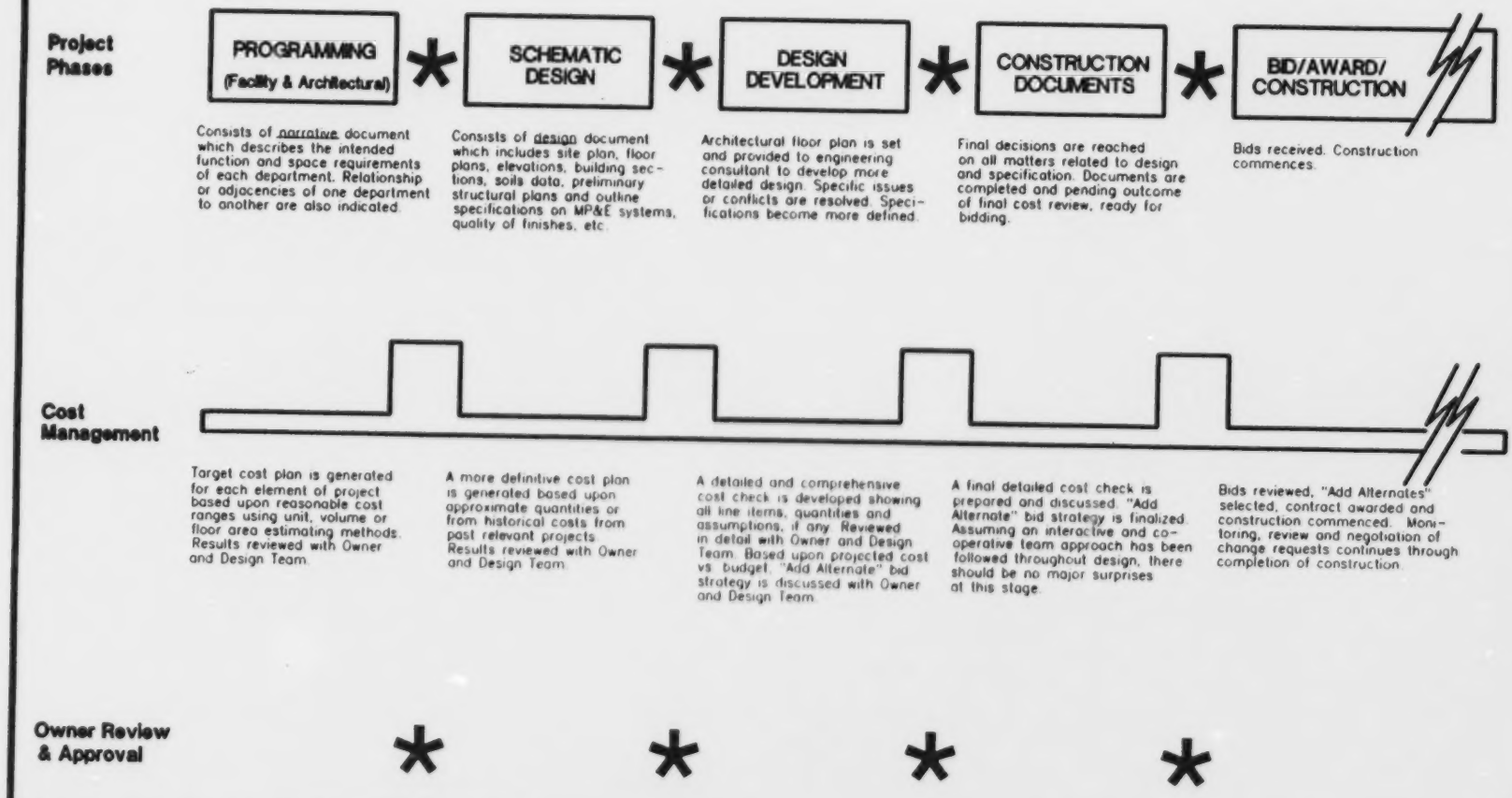
In summary, cost estimating is determining the "cost of a design", whereas, cost management is working with the design consultant to "design to a cost".

Procedure for Successful Cost Management

It must be emphasized that the key for successful cost management is first, the early and accurate definition of project scope and secondly, the identification of the associated costs to achieve such scope. But how do we accurately define the project scope?

The preparation of a detailed Architectural Program is essential. This document should be prepared by a design consultant who specializes in the type of facility required, i.e., science/laboratory facilities, library facilities, music facilities, etc. The facility program is a narrative document which through detailed input obtained from the owner and facility users, defines the space needs by department, the function of each department or room, the required adjacencies of one department to another, the desired systems, equipment and level of finishes, etc.

Cost Management Process


Project Phases
PROGRAMMING (Facility & Architectural)
SCHEMATIC DESIGN
DESIGN DEVELOPMENT
CONSTRUCTION DOCUMENTS
BID/AWARD/ CONSTRUCTION
Consists of narrative document which describes the intended function and space requirements of each department. Relationship or adjacencies of one department to another are also indicated.
Consists of design document which includes site plan, floor plans, elevations, building sections, soils data, preliminary structural plans and outline specifications on MP&E systems, quality of finishes, etc.
Architectural floor plan is set and provided to engineering consultant to develop more detailed design. Specific issues or conflicts are resolved. Specifications become more defined.
Final decisions are reached on all matters related to design and specification. Documents are completed and pending outcome of final cost review, ready for bidding.
Bids received. Construction commences.
Cost Management
Target cost plan is generated for each element of project based upon reasonable cost ranges using unit, volume or floor area estimating methods. Results reviewed with Owner and Design Team.
A more definitive cost plan is generated based upon approximate quantities or from historical costs from past relevant projects. Results reviewed with Owner and Design Team.
A detailed and comprehensive cost check is developed showing all line items, quantities and assumptions, if any. Reviewed in detail with Owner and Design Team. Based upon projected cost vs. budget, "Add Alternate" bid strategy is discussed with Owner and Design Team.
A final detailed cost check is prepared and discussed. "Add Alternate" bid strategy is finalized. Assuming an interactive and co-operative team approach has been followed throughout design, there should be no major surprises at this stage.
Bids reviewed, "Add Alternates" selected, contract awarded and construction commenced. Monitoring, review and negotiation of change requests continues through completion of construction.
Owner Review & Approval

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Through careful review and understanding of such an Architectural Program, a professional cost management consultant can accurately identify the reasonable construction budget to be allocated for such a project.

Thereafter, assuming funds are appropriated for such a project, it is essential that the design consultant and the cost management consultant work as a team to ensure that the design never strays from the budgetary parameters initially set. Communication is essential to minimize or prevent any scope or budgetary surprises later on in the design process.

The flow chart included on the following page illustrates the orderly and systematic sequence of events that when combined with input from competent and qualified cost professionals, will typically lead to a positive and successful project development experience.

Factors That Could Influence Bids

Successful cost management services require a detailed and comprehensive knowledge of the inter-relationship of design and construction activities and their associated impact on costs. Apart from knowledge of construction costs and their analytical build-up, it also requires an understanding of economic forces affecting the construction industry, the knowledge of procedures and trends in the area, etc., etc.

Anybody that has been involved with the design and construction industry for any length of time recognizes that it is an imprecise science. Many factors can and do influence the cost of a project. The following is a listing of just some of those factors:

- Economic condition of the marketplace
- Available workforce
- Availability of materials/suppliers
- Amount of marketing and exposure of the project
- Other projects with conflicting bid openings
- Dependent on climate, time of year that project bids
- Length of bid period
- Quality and completeness of documents
- Number & clarity of Add Alternates
- Tailor front end documents to fit project scope
- Responsiveness to calls and inquiries from bidders
- Extent of Addendums & time allotted to respond
- Contract completion date - is it reasonable?
- Liquidated damages clause - is it excessive?
- Past reputation of Owner - have you been fair?

These are but just a few of the factors that influence the success of any cost management program. If respected and followed by a qualified project team, your project should also be a success.

Project Costs vs Construction Costs

All too often, 100 percent of the cost control emphasis on a facility development program is given to the construction costs. Typically, the construction costs account for approximately 65 - 75 percent of the total project costs. Therefore, it must be emphasized that management of the total project budget is essential.

The following is a project budget format that has been successfully used by a major public university system for a number of years. It is but one of many budget formats that can be used, but nevertheless, includes the basic line items and categories that a typical project can reasonably anticipate.

TOTAL PROJECT BUDGET

PROJECT:

DESCRIPTION:

SOURCE OF FUNDS:

SCHEDULE	PROPOSED	REVISED	ACTUAL
Prelim. Plan Approval			
Bid Date			
Const. Period (Calendar Days)			
Occupancy Date			

	Program Estimate	Schematic Estimate	Design Dev. Estimate	Constr. Doc. Estimate
CAPITAL COSTS				
1. Land Acquisition	$	$	$	$
2. Construction Cost				
A. New Construction	$	$	$	$
B. Remodeling Renovation				
C. Special Fixed Equipment				
D. Site Development (excludes P&L)				
E. Parking and Landscaping (P&L)				
F. Utilities Extensions/Upgrades				
G. Other: _____				
Subtotal Construction Cost	$	$	$	$
3. Fees				
A. Construction Manager (___%)	$	$	$	$
B. Architect/Engineer (___%)				
C. Other: _____(___%)				
Subtotal Fees	$	$	$	$
4. F/F/E Movable	$	$	$	$
5. Contingency, Design Phase (___%)				
6. Contingency, Const. Phase (___%)				
7. Inflation Adjustment (__% x ___ mos.)				
8. Parking Reserve (_____ x _____)				
9. Utility Systems Reserve				
10. Telecommunications Equipment				
Subtotal Items 4-10	$	$	$	$
11. Additional University Costs				
A. Surveys and Tests	$	$	$	$
B. Move-in Costs				
C. Public Art				
D. Printing/Advertisement				
E. Other: _____				
Subtotal Add. University Costs	$	$	$	$
TOTAL CAPITAL COSTS	$	$	$	$

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Contingency Management

With fiscal limitations being place on every aspect of the business world today, rarely does a facility development program receive such generous appropriation of funds that cost control is not a major item of concern.

It is essential from project inception to properly identify the required scope of a facility, including future growth and expansion needs. With this information, the proper construction cost and total project budget can be assembled for project funding approval. Included as part of the Total Project Budget is an important line item called Contingency. If managed properly, contingency is a key element in successful cost control.

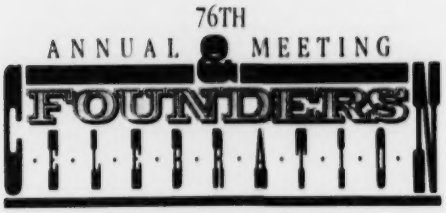
Contingency management involves the systematic process of reserving certain funds during the earliest stages of design and releasing such reserves as the design progresses and the details of the design documents become more specific and therefore, the accuracy of the cost checks or estimates increases. When insufficient project funds are appropriated from the start, the natural tendency is to deplete a portion or all of the contingency fund in the earliest design stages to solve the immediate problem. Typically, without exception, this only creates budget problems in the succeeding design phases.

Therefore, the following indicates the construction contingency percentages that should be maintained as a minimum at the completion of each design phase to ensure proper cost management:

o	Program	10% *
o	Schematic Design	8% *
o	Design Development	6% *
o	Construction Documents	4% *
o	Bid & Award	2% *

* For remodel/renovation it is reasonable to increase percentages by approximately 50%.

Naturally, many factors can influence the percentages indicated, i.e., remodel/renovation projects, site conditions, overall scope of project, design consultants, etc. However, we have found that when the indicated percentages were adhered to, projects were a success.



Managing Information Systems

The Computer: A Work Load Management Tool That Works

Kenneth G. Smith, P.E.
Engineering and Design Services Manager
University of Virginia

For all of recorded history, man has developed things to assist him in his work. The club, for instance, replaced the fist as a weapon, and as an instrument of work. Have you ever tried to break open a black walnut with your fist? Ideally, man's "tools" not only assist with the work, but also enhance the work effort.

The computer may well be the ultimate tool. Properly used, the computer is capable of producing information quickly and accurately. The Architectural and Engineering Services Division of the University of Virginia, Department of Physical Plant is using computers to allow Project Managers to maximize their time **Managing Projects**, rather than paperwork.

Why Bother?

To understand the valve of the computer as a work load management tool, let's examine the conditions and circumstances which generated the need for a workload management (WLM) tool. The University of Virginia is committee to enhancing its position as a major research institution while maintaining or improving the high calibre academics for which it is noted. This commitment, and the ever present march forward of technology, has generated a workload level that is trending steadily upward. At the University, typically each Project Manager is responsible for over twenty (20) renovation and capital projects. These may range from a several thousand dollar renovation to a several million dollar capital project.

In April 1985, ninety-one (91) active projects were being managed by engineering Project Managers. By April 1987, the number of active projects managed by engineering Project Managers had increased to one hundred thirty-one (131). The count in April 1989 was one hundred seventy-four (174) active projects being managed by engineering Project Managers. One can see that the work load is definitely increasing. These figures are representative of the workload for all three sections within Architectural and Engineering Services.

Fortunately, the University has been able to increase staffing too. This, however, generates additional workload in the form of training, personnel actions, and other management responsibilities. Staff turnover, generated by promotions and attrition, normally increases as staff increases as staff increased, which adds to the workload mentioned above.

The primary influence, however, is the need for quick access to accurate and reliable data. The tendency for one to use data in his management activities is inversely proportionate to the accessibility of the data. For instance, if all files are located in a separate room, several feet from one's work station, one tends not to make effective use of the data contained in the files. Ideally, all data required by a Project Manager to do his or her job well will be located at their fingertips. It is this very practical approach to the issue that has led the University of Virginia to the personal computer as a tool.

Getting Started

To get started, a significant "paper load" portion of the work load was targeted. The project budget was selected to be the first use of the new "tool". Some basic ground rules were established.

1. Standard off-the-shelf software was to be used.
2. The software should be "user friendly" with a very quick learning curve.
3. A budget template or "model", generic enough for use by all Project Managers, would be developed by personnel familiar with the software being used.
4. Training sessions would be held to assist Project Managers with getting started.

Two versions of the project budget were developed. One version is a skeletal form, using only basis budget line items. This version is used for smaller projects and preliminary scoping budgets. This version is shown as EXHIBIT 1.

A second, "full blown" version is used for the larger, capital projects. This version is shown as EXHIBIT 2.

Growing In Confidence

The next application installed on the computer was the timesheet. Prior to this, the posting and recording of time was a laborious proceed involving three separate entry points, by hand, by three different people. First, the employee filled out, by hand, his or her time sheet. Next, a member of the support staff summarized the time, by hand, onto a timecard form. Next, the timecard form was converted, by hand, into a data input card to send to the keypunch operation at administrative computing.

Now, with the computerized timesheet, the process is very different. Again, using off-the-shelf software, an automated timesheet has been developed. The program is menu driven, making it very user friendly. The first screen, shown as EXHIBIT 3, provides several choices for manipulation.

To enter weekly timesheet data, the Project Manager types 'A', and sees the screen shown in EXHIBIT 4.

The work order number is typed in at the backlighted space, and (enter) is keyed in. Depending on which weekending date being entered and whether this is an initial entry or not, eventually one is brought to the screen shown in EXHIBIT 5.

Enter the appropriate information in the spaces provided. An explanation of the terms in included at the end of this document. Key in the appropriate hours for each day. The lower set of spaces is for overtime. Key in (enter) for the advancement to the bottom of the screen shown in EXHIBIT 6.

If correct, key in 'Y'. The next screen, EXHIBIT 7, asks if one wants the data created on a coordinated data filed called "Projstat". More about this later. Key in 'N' and the basic data entry screen appears again. One would continue this process until all time for the week has been entered. Once finished, and back to the basic screen, key in 'end'. The timesheet main menu will appear. Type 'H' to print an individual timesheet and time ticket. See EXHIBITS 8 (timesheet) and 9 (time ticket).

In addition to combining the first two hand entries into one operation, the computer now has the data filed by week ending date. Also, labor amounts spent to date are automatically computed. Individual timesheet data may be merged to provide a total for any project.

Enhancing The Work

The data file mentioned above to be one coordinated with the timesheet data file is one named "Projstat" by the University. This is for Project Status. Again using a series of menus, one may enter significant and important data about a project. The data entry screen for projstat is shown in EXHIBIT 10.

The specific items of information that are important in your work may be included as a "field". What is shown here is an example only. The software provides tremendous flexibility. One may format reports for a wide variety of information. Examples are shown in EXHIBITS 11 and 12. EXHIBIT 13 identifies the Status Codes used in Timesheet and Projstat.

What Else?

Other applications are word-processing to generate form and memorandum templates, letters, and to do lists; inexpensive software to generate calendars, computer based rolladex files, and accounting processes; and, estimating. You will discover new and exciting uses for your operation.

The specific software types used by the University of Virginia Architectural and Engineering Services Division are:

1. Word Processing.
2. Data Base Management.
3. Spreadsheet.
4. Calendar.
5. CPM/Pert Planning.

A number of excellent software programs are available in each type. The University of Virginia Architectural and Engineering Services staff will be happy to share details, or to answer your questions.

BUD2113 BR=K38

UNIVERSITY OF VIRGINIA
Department of Physical Plant
Architectural & Engineering Services

PROJECT BUDGET

Project Title: ALDERMAN/MONROE HILL CHW LOOP
Work Order Number: 702113
Date: 00/00/00

SOURCE OF FUNDS: Fund Code 1-79813 36812

OBJ CODE	LINE ITEM		ORIGINAL BUDGET	ACTUAL BUDGET	SPENT TO DATE	AMOUNT OBLIGTD	BALANCE REMAIN
91000	BUILDING CONTRACTS		$500,000	$500,000	$0	$500,000	$0
92000	ARCHITECTURAL & ENGINEERING FEES		$45,000	$45,000	$0	$45,000	$0
93000	ARCH & ENGINEERING REIMBURSABLES		$1,000	$1,000	$0	$0	$1,000
94900	CONTRACT LANDSCAPING		$0	$0	$0	$0	$0
95000	WORK BY OWNER		$0	$0	$0	$0	$0
96000	PRELIMINARY COSTS		$3,000	$3,000	$0	$3,000	$0
97000	OWNER'S PROJECT COSTS		$35,000				$0
	CONST EST	$0		$0	$0	$0	
	PROJ MGT	$20,000		$20,000	$0	$20,000	
	CONST MGT	$15,000		$15,000	$0	$15,000	
98000	FURNISHING & EQUIPMENT BY OWNER		$0	$0	$0	$0	$0
99000	CONTINGENCIES		$50,000	$50,000	$0	$50,000	$0
	TOTAL ESTIMATED PROJECT COST		$642,000	$642,000	$0	$641,000	$1,000

NOTES:

EXHIBIT 2

PAGE 1 = Q57 PAGE 2 = A58 TO Q101 CUR BUD COL = K

Updated on:
Filename: B:
CONTRACTOR:
PROJECT:
ITEM C- (19 - BIEN.) P.C. W.O. 0

SOURCE OF REVENUE

HOSPITAL OPERATING REVENUE 0309	$0
OVERHEAD 0303	$0
UNIVERSITY FUNDS 0302	$0
UNIVERSITY GRANTS 0301	$0
TOTAL	$0

	DIVISIONS	ORIGINAL BUDGET (CO-0)	CURRENT BUDGET	EXPENSES TO DATE	OBLIGATED	BALANCE TO DATE
91000	BUILDING CONTRACTS	$0	$0			
100	PRIME CONTRACT	$0	$0	$0	$0	$0
101	UTILITIES	$0	$0			$0
	CHANGE ORDERS	$0	$0			$0
	CONTINGENCIES	$0	$0			$0
	Sub Total:	$0	$0			
92000	ARCH & ENG FEES	$0	$0			
100	BASIC CONTRACT FEE	$0	$0	$0	$0	$0
	CHANGE ORDER FEES	$0	$0	$0		$0
300	PROJECT REPRESENTATIVE	$0	$0			$0
	Sub Total:	$0	$0			

93000	ARCH & ENG REIMBURSABLES		$0			$0					
100	REPRODUCTION	$0			$0			$0			$0
300	PROFESSIONAL ESTIMATES	$0			$0			$0			$0
400	ADVERTISING	$0			$0			$0			$0
700	LOCATION STUDY	$0			$0			$0			$0
	Sub Total:	$0			$0						
94000	CONTRACT LANDSCAPING	$0	$0		$0	$0					$0
95000	WORK BY OTHERS		$0			$0					
100	LOCATE UTILITIES	$0			$0			$0			$0
200	ELECTRIC SERVICE	$0			$0			$0			$0
900	GENERAL CONSTRUCTION	$0			$0			$0			$0
	Sub Total:	$0			$0						
96000	PRELIMINARY COSTS		$0			$0					
100	SURVEYS	$0			$0						$0
200	TEST BORINGS	$0			$0						$0
		$0			$0						
97000	OWNER'S PROJECT COSTS		$0			$0					
100	CONSTRUCTION MANAGEMENT	$0			$0			$0			$0
200	PROJECT MANAGEMENT	$0			$0			$0			$0
600	MATERIALS TESTING	$0			$0			$0			$0
800	TELEPHONE SERVICE	$0			$0			$0			$0
801	TELEPHONE INSTALLATION	$0			$0			$0			$0
	Sub Total:	$0			$0						

EXHIBIT 2 (cont'd)

	DIVISIONS	ORIGINAL BUDGET (CO-8)		CURRENT BUDGET		EXPENSES TO DATE	OBLIGATED	BALANCE TO DATE
98000	FURNISHINGS & EQUIPMENT	$0	$0	$0	$0			$0
99000	CONTINGENCIES		$0		$0			
100	MISCELLANEOUS CONTINGENCY	$0		$0		$0		$0
200	CONSTRUCTION CONTINGENCY	$0		$0				$0
	Sub Total:	$0		$0				
TOTAL PROJECT COSTS			$0	$0	$0	$0	$0	$0

APPROVED CHANGE ORDERS	AMOUNT	ENCUMBRANCES	AMOUNT
01 -	$0	-----	$0
02 -	$0	-----	$0
03 -	$0	-----	$0
04 -	$0	-----	$0
05 -	$0	-----	$0
06 -	$0	-----	$0
07 -	$0	-----	$0
08 -	$0	-----	$0
09 -	$0	-----	$0
010 -	$0	-----	$0
TOTAL CHANGE ORDER COSTS:	$0	TOTAL ENCUMBRANCES	$0

EXHIBIT 3

University of Virginia Physical Plant
A & E Services Employee Time Sheets and Budget Information (Version 2.0)
04/18/89

A) Add Employee Time Sheet Data. (to be done by employee)
B) Chg/Verify timesheet data for a Project Mgr. (to be done by employee)
C) Check bottom line hours worked & view timesheet on screen.

E) Add/Change Billrates for a Project Mgr.(to be done by supervisor)

F) Delete a Timesheet Record.
G) Pack and Reindex the Files.

H) Print an Individual Employee Time Sheet and Time Ticket.
I) Print a Blank Time Sheet.

J) Print a Budget Summary Report for Projects.
K) Move timesheet data to the archive file.
L) View archived timesheet data.

R) Return to Previous Menu. Q) Quit.
Press any key to continue...

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EXHIBIT 4

Please enter the Work Order # or key in END to finish work.

173

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EXHIBIT 5

```
   The following data is on file for Work Order 555555
   for MOORE, J.    for the Week Ending: 03/31/89
   Status Codes (Primary then Secondary)          Work Center

PROJECT TITLE (Shorter version than PROJSTAT)

            NORMAL HOURS WORKED
            SASU : MON : TUE : WED : THU : FRI :
            -------------------------------------
            0.0    0.0   0.0   0.0   0.0   0.0

           COMPENSATORY HOURS WORKED
            SASU : MON : TUE : WED : THU : FRI :
            -------------------------------------
            0.0    0.0   0.0   0.0   0.0   0.0
 CONSTRUCTION COST         0 PROJECT COST         0 PROJECT MANAGER COST         0
```

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EXHIBIT 6

```
   The following data is on file for Work Order 555555
   for MOORE, J.    for the Week Ending: 00/00/00
   Status Codes (Primary then Secondary) 021      Work Center 08

PROJECT TITLE (Shorter version than PROJSTAT) THIS IS A TEST

            NORMAL HOURS WORKED
            SASU : MON : TUE : WED : THU : FRI :
            -------------------------------------
            0.0    1.0   1.5   0.0   2.0   0.0

           COMPENSATORY HOURS WORKED
            SASU : MON : TUE : WED : THU : FRI :
            -------------------------------------
            0.0    3.0   0.0   0.0   0.0   0.0
 CONSTRUCTION COST    12300 PROJECT COST    19000 PROJECT MANAGER COST       600
 The total of  7.5 hours of work is being written to the file.
 Is the above data correct? Key in a Y or N
```

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EXHIBIT 7

Do you want to update the Projstat File with these changes?

EXHIBIT 8

UNIVERSITY OF VIRGINIA

ARCHITECTURAL AND ENGINEERING SERVICES

NAME	WEEK ENDING	RATE	SHEET	REVISED
BERNIE CAULEY	05/27/88			10/22/87

WORK ORDER	PROJECT NAME	CODE		HOURS WORKED AND COMMENTS						INDIRECT	DIRECT	FIXED
				SASU	MON	TUE	WED	THU	FRI	HRS	HRS	PRICE
074955	DARDEN SCHOOL ADDITION & RENOVATE	062	N				1.0	3.0	2.0		6.0	
700872	THE MILLER CENTER ADDITION	062	N		1.0	6.5	0.5	0.5	3.5			
			C			2.5					14.5	
A01000	MANAGEMENT ALLOWED	NA	N		3.0			1.5	0.5			
			C			2.5			1.0	8.5		
A01000	CAPITAL PROGRAM ANALYSIS	NA	N			1.5	5.5	3.0	1.5			
			C				4.5	4.0		20.0		
A01000	IN-HOUSE CONTRACT ADMINISTRATION	NA	N									
A01000	MAINTENANCE RESERVE PROGRAM	NA	N		1.5					1.5		
A01000	A & B PRIORITY MEETINGS	NA	N				1.0			1.0		
A03000	GENERAL ADMIN	NA	N		1.0				0.5	1.5		
A05000	GENERAL LOCAL TRAINING	NA	N		1.5					1.5		
	NORMAL WORK WEEK TOTALS ===>			0.0	8.0	8.0	8.0	8.0	8.0	34.0	20.5	0.0
	COMP TIME DAILY TOTALS ===>			0.0	0.0	5.0	4.5	4.0	1.0			

An 'N' next to Work Hours Denotes Normal Hours and a 'C' Denotes Compensatory Time Earned.

PROJECT STATUS CODES

011 Maintenance Reserve 021 PIR 061,062,063 Design
071,072 Estimate 081,082,091,092,093,101,102,103,104 Construction
111,112 Archive 121,122,123 Hold

NORMAL HOURS TOTAL FOR WEEK	40.0
COMP TIME TOTAL FOR WEEK	14.5

EMPLOYEE SIGNATURE _____

APPROVAL SIGNATURE _____

BEST COPY AVAILABLE

EXHIBIT 9

DATE	EMPLOYEE NO.
Ø5-27	E15Ø2

NAME: BERNIE CAULEY

WK ORD	WK CTR	TYPE	TIME
X74955	Ø8	1 1 Ø	Ø6.Ø
7ØØ872	Ø8	1 1 Ø	12.Ø
7ØØ872	Ø8	1 8 Ø	Ø2.5
AØ1Ø8Ø	Ø8	1 1 Ø	Ø5.Ø
AØ1Ø8Ø	Ø8	1 8 Ø	Ø3.5
AØ1Ø8Ø	Ø8	1 1 Ø	11.5
AØ1Ø8Ø	Ø8	1 8 Ø	Ø8.5
AØ1Ø8Ø	Ø8	1 1 Ø	Ø1.5
AØ1Ø8Ø	Ø8	1 1 Ø	Ø1.Ø
AØ3Ø8Ø	Ø8	1 1 Ø	Ø1.5

Date-Record Month and Day- For Example: Ø6Ø6

Employee No.-Record in right most boxes and fill all empty boxes with zeroes- For Example: Ø059

Type- 1=Regular Time 3=Call Back
2=Allowed Time 4=Essential Overtime
8=Compensatory Time (Earned)

Work Center-Record if different from your assigned work center

Time-Record the amount of time worked on each job. One-half (1/2) hour should be written as .5 and whole hours must be written with trailing zeroes- For Example: Ø2.Ø

Overtime must be authorized by supervisors signature

EXHIBIT 9
(cond't)

DATE	EMPLOYEE NO.
Ø5-27	E15Ø2

NAME: BERNIE CAULEY

WK ORD	WK CTR	TYPE	TIME
AØ5ØBØ	Ø8	1 1 Ø	Ø1.5
	TOTAL HOURS		54.5

Date-Record Month and Day- For Example: Ø6Ø6

Employee No.-Record in right most boxes and fill all empty boxes with zeroes- For Example: ØØ59

Type- 1=Regular Time 3=Call Back
2=Allowed Time 4=Essential Overtime
8=Compensatory Time (Earned)

Work Center-Record if different from your assigned work center

Time-Record the amount of time worked on each job. One-half (1/2) hour should be written as .5 and whole hours must be written with trailing zeroes- For Example: Ø2.Ø

Overtime must be authorized by supervisors signature

_____

EXHIBIT 10

PROJECT STATUS DATA ENTRY SCREEN

WORK ORDER 700872

PROJECT NAME THE MILLER CENTER ADDITION

BUILDING ' 603 SQUARE FEET 88000 BUILDING CATEGORY

PRIORITY CO RECEIVED DATE PROJECT MANAGER CAULEY

STATUS 062 SECTION U PIRFWD NA PIROKD NA

COMMENTS THE BUILDING COMMITTEE HAS APPROVED THE SCHEMATIC DRAWINGS. STATE APP
ROVALS HAVE BEEN REQUESTED. INTERNAL STAFFING HAS BEGUN. ARCHITECTURAL
REVIEW COMMITTEE AND LANDSCAPE AND ABORETUM COMMITTEE APPROVALS HAVE
BEEN RECEIVED. 5/23 PM

CONSTRUCTION COST 1316100 PROJECT COST 1841700

PROJECT MANAGER COST 42200 ADMINISTRATION UNIT

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Display next (N) record, or quit (Q)?

EXHIBIT 11

A & E SERVICES PROJECT STATUS REPORT

W.O.NO.	PROJ NAME & RM #'S	BLDG(S)	PRI	DATE RCVD	PROJ MNGR	STAT	SECT	PIR FWD'D	PIR OK'D	COMMENTS/DETAILED STATUS
180										
072293	UPGRADE MAIN ENTRANCE OLD MED SCHOOL	181	C	05/01/84	MCDERMOTT	082184 D		05/28/85	N/A	Construction complete, punch list cleared with the exception of asphalt patching. As-builts pending. HVAC maintenance ladder design and installation pending. Plant material and Holly tree installation pending. 05/31

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702284	INVESTIGATE CROSSWALK/LIGHTING REQUIREMENTS/RUFFNER BRIDGE	C	02/26/88	MCDERMOTT	021122 D	Work Order on hold pending reply from Werner Sensbach to Boyd Anderson's memo request of FEB 26th regarding liaison with the City.
702313	IMPROVE LIGHTING AT CLARK HALL	C	03/14/88	MCDERMOTT	021122 D	Project on hold until 1 JUL 88 due lack of PS funds. Requester concurs.
702316	INSTALL SECURITY BARS LAW LIBRARY, 3RD FLOOR	C	04/05/88	MCDERMOTT	021122 D	Project on hold until 1 JUL 88 due lack of PS funds. Requester concurs.
702337	INTERIOR RENOVATION/FOOD CENTER	C	04/07/88	MCDERMOTT	021122 D	Project on hold until 1 JUL 88 due lack of PS funds. Requester concurs.
702358	INSTALL/RECONNECT FIRE/SECURITY SYSTEM CABELL/BERRY HALL	C	04/22/88	MCDERMOTT	021122 D	Project on hold until 1 JUL 88 due lack of PS funds. Requester concurs.
702361	INVESTIGATE HVAC SYSTEM FOR EQUAL OPPORTUNITY/AFFIRM ACTION.	C	04/25/88	MCDERMOTT	021122 D	Project on hold until 1 JUL 88 due lack of PS funds. Requester concurs.
702365	INSTALL TWO DOCK LEVELERS ON BACK DOCK OF FOOD CENTER	C	04/29/88	MCDERMOTT	021122 D	Project on hold until 1 JUL 88 due lack of PS funds. Requester concurs.

EXHIBIT 12

PROJECT COST SUMMARY

W.O. #	PROJ NAME	PROJ MGR	CONST COST	PROJ COST	P.M. COST
720241	JORDAN HALL AMPHITHEATERS	WAITE	93000	14900	1600
720261	BILIARY LITHOTRIPTER FACILITIES RENOVATION	WAITE	223012	352300	29600
720268	OB/GYN CREATE OFFICES	WAITE	8800	14000	1400
720274	RENOVATE ROOMS FOR VIVARIUM	WAITE	79000	100000	6000
720276	SPEC. MAT. HAND. FAC. ADDITION	WAITE	406811	496724	11500
720271	REPLACE STEPS AT MCKIM HALL	WAITE	20600	32200	3000
720312	LEKSELL GAMMA UNIT	WAITE	493000	2580000	60000
720311	SIGNAGE FOR STACEY HALL	WAITE	0	0	0
720318	SUBDIVIDE ROOMS - PRIMARY CARE CENTER	WAITE	13000	20000	2800
072270	MED/COMP/RENOVATE ANIMAL HOLDING ROOMS/1194	WAITE	110220	155313	7500
700605	MR-4 ADDITION (RADIOLOGICAL RESEARCH LABORATORY)	WAITE	8182918	8978000	116143
720216	MR-4 ADDITION/VERTICAL EXPANSION/1988-90 BIEN.	WAITE	11550500	13449500	191000
071986	ADDITION TO MEDICAL RESEARCH BUILDING MR-4, 2ND & 3RD FLRS	DIEHL	3711584	4099800	102105
075227	ALTERATIONS AND RENOVATIONS AT BRH	DIEHL	77600	96991	12800
072114	KIDNEY LITHOTRIPTER FACILITY (ADDITION)	DIEHL	1396313	1715500	50631
701002	STRUCTURAL INSPECTION/MEDICAL CENTER PARKING GARAGE	DIEHL	115000	157500	8000
701672	REPAIR/REPLACE ROOF MEDCEN GARAGE BLDG #1144	DIEHL	3430	8300	1300
720150	PHP/MCPP/NEW ROOF/1172	DIEHL	7798	13900	1200
720209	BRH/INVESTIGATE EXHAUST FUMES/1902	DIEHL	17820	32000	2700
720253	AUPH/HSLI/COMPUTER ROOM/1141	DIEHL	65000	80000	6000
730801	PHP/MCPP/REPLACE BUILT-UP ROOFING/1181	DIEHL	4341	8760	1100

730887	HOPS/GSER/RENOVATION OF RESTROOM/1195	DIEHL	9000	20000	2000
730896	PHP/MCPP/REPLACE BUILT-UP ROOF/1179	DIEHL	8598	14100	1200
720245	HCLS/CARC/PERFORM POWER SURVEY/1175	DIEHL	110000	142000	17000
071783	MR017 MCLEOD HALL/REPLACE ROOF	DIEHL	117000	153000	7600
720255	BRH/RENOVATE ROOMS/2168,2103,2106 & 2166,2104-1902	DIEHL	28000	34000	6000
730682	PHP/MCPP/REPLACE ROOFING/1172	DIEHL	165500	200000	10000
730990	PHP/MCPP/REPLACE EXISTING ROOFING/1142	DIEHL	1000	2000	500
731014	HCLS/CARC/INSTALL AIR CONDITIONING/1180	DIEHL	1500	2500	400
720301	MED/PROVIDE-INSTALL FUMEHOOD/1157/#3002	DIEHL	5500	7800	600
720309	BRH/REMOVE PARTITIONS ETC./3RD FL./1902	DIEHL	20000	24000	2000

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EXHIBIT 13

PROJECT STATUS CODES

PRIMARY CODES	SECONDARY CODES	TITLES
MAINTENANCE RESERVE		
	011	Maintenance Reserve (Note: This is a SECONDARY code to be used on all maintenance reserve projects).
PIR		
021		PIR (Includes complete cycle of: receipt of work order; preparation and forwarding of report; and period of review by requestor pending approval)

DESIGN

Ø61	Design by A&E Services Design Group
Ø62	Design by Outside Consultant
Ø63	Design In-House by a Project Manager or Landscape Architect

ESTIMATE

Ø71	Preliminary Price Estimate (Informal)
Ø72	Construction Price Estimate (Formal Fixed or Cost Reimbursable)
Ø73	Public Bid

CONSTRUCTION

Ø81	Construction by Physical Plant Shops
Ø82	Construction by Outside Contractor
Ø91	Change Order (Pending)
Ø92	Change Order (Being Priced)
Ø93	Change Order (In Construction)
1Ø1	Awaiting Closeout
1Ø2	Clearing Punchlist
1Ø3	Pending Warranty Item
1Ø4	Pending As-Builts

ARCHIVE

111	Project Completed - Archive Report
112	Project Canceled - Archive Report

HOLD

121	Requestor Hold
122	Funding Hold
123	Material Hold

Automating Plant Maintenance Pays Off: Myth or Reality

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Overview

Today plant maintenance is at the forefront of each of our thoughts. How has plant maintenance changed over the years? How does it operate today? What changes can be expected tomorrow? And, can automating plant maintenance help improve your operation?

As you think about these questions, I'd like to review some of the salient points in the history of plant maintenance and discuss the requirements for an integrated systems approach to plant maintenance. During this presentation, I will relate two case histories of the results of an automated plant maintenance system, and then offer some conclusions and recommendations.

Introduction

Maintenance of plant and facilities can be traced to the very beginning of time. Consider the plight of the cave dwellers who suddenly had water seeping from the roof or had the vent blocked which carried out smoke. The cave dweller was a generalist: Not only was he the provider of all food, he was the full crew for repair of any problem in the "house" where he and his family lived.

Contrast this primitive environment with the ancient Egyptians. Their facility engineers constructed marvelous structures which are viewed today as wonders of the ancient world. The sphinx and pyramids required little maintenance as they were permanent monuments which blended with the environment. However, their public buildings required a more sophisticated work force than the cave dwellers. By this time, the division of labor had started. Stone cutters and masons, albeit slaves, were involved in both construction and repair. Household or "temple servants" performed the custodial work. Of interest, we might conclude the sphinx and pyramids required little maintenance as they were not occupied. The temples and palaces required maintenance and they no longer stand.

As civilizations rose and declined, both facilities construction and facility repair became more complex. Here in America we evolved from primitive conditions into large, complex facilities requiring sizable support staffs for maintenance. From single story structures in the 15th and 16th centuries to the world's tallest buildings and largest complexes under one roof in the 20th century.

The complexity of plant maintenance has escalated into a maze of interrelated requirements. In the complex environment of today's facilities, multiple specialized skills are required to repair highly sophisticated environmental control systems and to repair or modify composite materials. We must react to emergency breakdowns and at the same time continue to plan where our workforce can be most productive, while using in-house or out-house (contract) sources for both material and labor. If we believe the forecasts of the future, we'll have integrated plant systems (i.e., integrated environmental, custodial, people movers, communications network, etc.) where the plant maintenance equation will, in all likelihood, require a different skills mix to accommodate the technology of tomorrows "Integrated Plant Systems". Today's plant maintenance, with all its complexity, poses the question - is the need for *AUTOMATING PLANT MAINTENANCE - A MYTH OR REALITY?* The integrated plant systems of tomorrow demand we pose the very same question.

Plant maintenance requirements fall into two key functional areas:

1. Maintenance

This encompasses a wide range of factors including but not limited to the topics discussed below.

Facility/Equipment Definition: In order to successfully accomplish timely and effective maintenance, whether preventive, planned or reactive, the area within the facility, the equipment and its location must be defined. With this information, the

craftsman will know where to go and what equipment or room/floor/wall needs repair. The breakout of the definition of facility and/or equipment should be based upon the level of detail necessary to write work orders, dispatch craftsman and collect costs.

Facility/equipment parts lists (Bill of Materials): To facilitate ordering parts used in repair, parts lists are often developed for craftsmen and planners. These parts lists are used to identify the components or assemblies which are often replaced when a failure causes repair action.

Craftsmen: Maintenance requires either in-house (or plant) or out-house (contract) labor. With today's sophisticated facility/equipment a variety of skills are required. Specialized training in electronics and materials has come to the forefront as automated systems (environmental) become the standard in today's modern plant environments. In addition, advanced components are being used in a variety of areas as new facilities are constructed or refurbished and as new, more reliable equipment (HVAC, plumbing, electrical wiring) are installed. These are changing the skill bases required for plant maintenance.

Preventive Maintenance: All facilities and equipment have both inspection and repair requirements based upon calendar time or some form of limit (operating hours, vibration measure, etc.). An example of the requirements for a repetitive job which is a preventive maintenance tool is the testing of the air conditioning system during the cold weather months or the lubrication of bearings and rotating parts of back-up systems. The preventive maintenance activities require some form of documentation to record when an inspection/lubrication/repair has been completed and a tickler file to alert when the next one is due.

Work Orders/Job Orders: These are used to notify the craftsperson when work is to be done, what needs to be done and record what has been done. A work order can range from a note taken over the telephone to a printed detailed listing of what equipment, task, skill and parts are required to perform the work. Also, work orders are used to record the actual issue of material and expenditure of labor for comparison of the plan to the actual results. They can also be used as the source documents to summarize the costs of facility/equipment repair.

2. Material Management

The material management arena encompasses both the warehouse (storeroom) activity and the purchasing function. These activities are so integral to maintenance management that studies have documented 80 percent of storeroom and purchasing

activities are directly maintenance related, regardless of industry or public sector. Material management factors are outlined below:

Stock catalog: A detailed listing of those parts which are stocked and/or recurringly used for maintenance. This provides a record for craftspeople to use when looking up parts information for ordering or for requisitioning.

Storeroom or warehouse stock locations: For small facilities this is often a "storeroom" near the craftspeople. For large facility complexes there may be a number of separate stockrooms, each housing similar and dissimilar items. If there are multiple storerooms, there is the requirement to know where common or similar parts are stored, regardless of the storeroom.

Stock levels: If the facility maintenance requirement includes the need to maintain stock at the facility, inventory managers must have reorder points and reorder quantities established on each item. These stocking levels are set at each storehouse and if a central/satellite complex is established, can provide central leveling when desired.

Stock Reorders/Orders: In order to provide needed stock levels, the storeroom personnel must have some capability to know when an item hits the reorder point and then place items on order. In addition, non-catalogue items needed for facility maintenance need to be ordered and some means set up to relate the results for receipts to the work order.

Requisitions/Purchase Orders: As items are placed on order, the organization making the request needs to have a means to track the status from the time submitted, through approval, to creation and submittal of a purchase order, to the vendor. Purchasing can have single item or multiple item orders. In addition, for large/complex facilities, blanket orders by line item or by dollar value may be used. This provides the flexibility to order "on the spot" without going through extensive approval levels or generating excessive paper work.

The arenas of maintenance and material management are fully integrated. The purchase order for spare parts to support maintenance needs to be recorded on the stock record. The material requirements for work orders need to be included in stock records so timely purchase orders can be released. And, of course, the equipment/facility repair, craftspeople and material need to be planned and scheduled to obtain the most responsive maintenance and low cost alternative.

Each institution represented at this conference has its unique approach to facility maintenance. A broad range of maintenance approaches are represented. Some of you may function from a centralized call-in point for all trouble reports or facility change requests. This central point also plans and schedules inspection/repairs. Through centralized planning and scheduling, resources can be balanced across a multitude of requirements at different points within the facility complex. While centralized control can be effective, many of you may use some form of decentralized operations. If your responsibility spans several campuses throughout the state or region, or across a large geographic area, you might use a decentralized approach. That is, you would have dispersed call-in, planning and scheduling offices to ensure the most responsive and efficient response of facilities maintenance.

I've inferred that all of us do planning and scheduling. Whether you plan for day to day maintenance by looking ahead 45 days for work order requirements versus crafts capability or just assign work at the start of each day you're "scheduling". However, the person who schedules at the start of the day without looking at the future requirements is being "reactive". A "proactive" maintenance leader looks to the future for what needs to be done. Through looking at the future, peaks and valleys of work can be accommodated without full disruption of the workforce.

Maintenance System Requirements

An automated maintenance system must support the requirements described earlier. Automated systems can reduce a large amount of unnecessary paperwork. For example, requisitions can be stored electronically. Work orders can be entered into the computer and only printed when required as part of a job package. In addition, an automated system can provide equipment records, summary cost information, work order status, backlogs, etc. at your finger tips. Plus, as facilities become the futuristic "facility system" described earlier, the requirements for inspection and repair will no longer be assigned to generalists. They will be given to specialists who will need detailed technical procedures to trouble shoot and effect repair.

The automated system must be capable of handling the various factors I've discussed earlier. Facilities and equipment need to be defined and a variety of look-up inquiries are needed for use by craftspeople and managers. Equipment should have bills of material identified and available to the planners and craftspeople. The maintenance workforce needs to know what their daily schedule will be, before the day begins rather than "react" to problems. Job packages detailing the technical steps for repair need to be printed for use at the job site, whether for capital projects, minor capital projects or routine work. Costs should be collected and available so management can make replacement decisions and budget for the next year's requirements.

In the material management arena there should be a full integration between the work orders planned and scheduled, the reservation of material to these work orders and the placement of stock on order so work can begin with full material support. The capability to manage the inventory control and purchasing operation is critical to support facility maintenance which will account for 80 percent of the activity.

In addition, an automated system should set the stage for the facility maintenance superintendent to become "proactive" in planning and scheduling day to day operations. Managers need to know what backlog of work needs to be done and should have a computer system to automatically schedule the repetitive, preventive maintenance tasks on a calendar basis, on an operating tempo basis, or on measures of limit such as ball bearing vibrations. With this type of system, the facility maintenance superintendent can manage the complex inspection and repair environment of today's and tomorrow's facility systems.

Case Histories

The pay offs from an on-line, proactive maintenance management system will be discussed in the case histories outlined below. Case History "A" deals with a centralized concept of operation. Case history "B" illustrates a decentralized operation.

Case History "A"

The seventh largest school district in the United States has completed three phases of a five phase implementation of an on-line maintenance management system. Phase one was completed when equipment, inventory, craftspeople, bills of material and a limited number of preventive maintenance jobs were loaded in the system. The remaining phases include interfaces to accounting and payroll systems, development of a planning capability and full implementation of standard jobs triggering all inspection and repair activity.

This school district has more than 150 facilities located throughout a 1500 square mile area. They maintain over 1,000 school buses and over 1,300 pieces of other equipment items ranging from grounds support mowers to heavy equipment such as graders and dump trucks. In addition, they are in the process of loading all personal computers on their maintenance system. Of interest, they have some 13,000 PC's loaded in equipment records and believe they are only 50 percent complete.

The district decided to acquire an automated maintenance system, after state auditors had repeatedly criticized their inability to show what their cost of repair was for any given school bus or any of their facilities. They had used written work orders to authorize work and counted on the internal distribution system to route the record of their work back to the clerical staff to file the completed work orders in jacket files. When the history of repair of a bus, fence or whatever was needed, supervisors and clerks would search the jacket file, calculate labor and material costs and after one to two weeks, produce the report. However, they never knew if all repair action had been recorded. In addition, the principals who were responsible for budgeting the maintenance of their own facilities, never knew the backlog of repair (i.e., what work orders were pending), their annual cost of repair, or whether facilities maintenance was responsive and holding the backlog at a minimum.

Once this district decided on a computerized maintenance system, they set an aggressive schedule to implement Phase I - load the facility and vehicle data within six months. Of interest, I wouldn't recommend to any facility maintenance superintendent that he transition from a purely manual, paper intensive operation to on-line in six months. The cultural change is dramatic. Regardless, this district achieved their objective and began using a computer based system.

Today, they have successfully been using the system and are continually expanding its use. Here are some of the results.

1. All facility and vehicle work orders are generated at a central control facility. Vehicle maintenance operates from three geographically separate garages supporting the North, Central and South areas of the county. Facility maintenance is dispatched from geographically separate areas and through remote repair teams via telephone contacts.

2. Over 460 craftspeople's time cards are input through the system daily. This captures labor costs (regular and overtime) reported on work orders and electronically feeds these hours to a payroll system for processing.

3. Principals receive a monthly summary of their work backlog, the work accomplished and the planned status of when the rest of the work will be done. This provides their information for annual budgets.

4. The state law requiring a 5 year history of inspections and repair on bus brake systems and drive trains, and this information is available through an on-line inquiry, thus reducing hours of research by supervisor and clerical staff.

5. Material support to both vehicle and facility repair has improved, as backlogs of work for material shortages have been reduced to only long lead time items.

6. Tracking of responsiveness to work order call-ins is now possible. From the time of the trouble call to the completion of repair, the central control facility can provide immediate status of any job.

7. And, most important to those who had to answer state audit reports, they have received kudos for the last two years. They now know the "cost of repair".

Case History "B"

Case History "B" involves a facility which has both building and equipment maintenance. It is a mid-sized chemical plant in Alabama which implemented an on-line maintenance system in the early 1980's. The results achieved through use of the maintenance system was documented by the maintenance superintendent. While the Association of Physical Plant Administrators primarily focuses on the classic facility maintenance of campuses and building complexes, the results from Case History "B" can be used as a comparison of what is "reality".

The physical plant of the facility in Alabama covers a 950 acre area. It has approximately 150 maintenance technicians and a central store room. Work requirements include preventive maintenance inspections and repair, repetitive jobs such as patching steam pipes, emergency jobs when equipment fails and "turn arounds" or complete tear down and repair of sections of the plant. A complete repair of the boiler within one of your facilities would be a reasonable comparison to a "turn around".

The planning and scheduling of work is decentralized to "line superintendents" who are responsible for individual crews. There is some cross flow of crafts between lines, and the system they use provides the capability to manage this cross flow. The store room supports each line and delivers required material to the job site. Here are some of the results presented in a paper titled $7 Million Dollars Cost Savings in Seven Years.

1. Through use of the automated system, the plant was able to save $4.9M in material costs over the seven year period. This included cancelling over-maximum stock on-order, reducing over-maximum levels, reducing manpower and correcting pricing errors.

2. The plant achieved higher productivity from the maintenance work force estimated at $5.2M.

3. Combining the savings ($4.9M material and $5.2M increased productivity) and netting the actual cost ($2.9M) of implementing and using the system, the net savings is $7.2M in seven years.

4. Deliveries increased from 90 per day to an average of 160 per day.

5. Total inventory value stocked decreased by seven percent.

6. Emergency purchases were reduced by 50 percent.

7. Stock outage decreased from 20 percent to less than 3 percent.

8. Inventory accuracy increased from 88.5 percent to 99.5 percent.

9. Maintenance productivity in terms of direct work increased from 37 percent to over 55 percent.

10. Most important - employee morale increased.

Observations and Suggestions

An automated maintenance system can provide real benefits to those who plan for them, implement them and use them. Selecting a plant maintenance system can be one of the most important decisions you make. Here's some pointers:

1. Pick a company whose sole business is maintenance management software and consulting. Be cautious of a pure software house, as you will likely need help in bringing the system into full production.

2. Don't underestimate your requirements for a mainframe or mini-frame based system. Personal computer software has attractive pricing between $1,000 - 10,000. However, if you need five years of repair history to support regulatory requirements, the PC will burst before it can hold all that data.

3. Don't settle for less than a fully integrated management system to cover the broad spectrum of maintenance, inventory control, purchasing and other related areas.

4. Have an internal company program advocate to help you successfully implement the system of your choice.

In conclusion, facility management is an exciting arena. We're moving towards integrated facility systems which will provide better climate for the work or study place. The responsibility for maintaining these facility systems will continue to grow. As you step in to the future, step in with an on-line, integrated maintenance management system to support your facilities of the future.

Qayoumi

Integrated Information Systems for Facilities Management

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Introduction:

Managing an organization consists of a continual decision making process. The decisions are made based on the best information available. In a dynamic environment conditions change very rapidly where the difference between the latest information and previous one can possibly alter decisions 180 degrees. That is why the information system is the nerve system of an organization that provides the fundamental pillars for making decisions at all organizational levels. Information is much more than a mere collection of data for the simple reason that the whole is more than the summation of parts. So, what is information? It is very difficult to arrive at a definition that is commonly acceptable. Information reduces uncertainty which helps us better understand a condition. Information is the antithesis of entropy and a means to understand and perceive the world.

Information can be viewed as an asset or a strategic commodity and a valuable resource. From this, one can conclude that information can be measured with predetermined quantifiable units. Unfortunately, measuring information in such a manner is not possible. However, one can discuss

information value and quality. The value of information can be normative, realistic, subjective, and relative.

Suppose an individual is planning to buy a particular stock for short term gain. In the meantime he can acquire some information regarding the firm. If one can statistically calculate the expected value of the stock with and without information; this difference is normative value of information. Now in practice, when the stock is sold, the difference between utilizing or not utilizing the information is the realistic value of information. On the other hand, if a market expert is asked for his input in stock purchases, the value of stock with and without this opinion is subjective information. The attributes of information are timeliness, content, format, and cost.

There are various ways to manage information. But the best way to avoid suboptimization is a systems approach that coordinates all elements within an efficient structure. Since the whole is more than the summation of parts, synergism is an important attribute of a structure. A systems approach consists of defining the problem, gathering relevant data, identifying alternate solutions, selecting the best solution, and finally implementing and monitoring the selected alternatives.

Information management will only be relevant and useful if it is an integral part of overall organizational planning. In other words, it should be an organic part of an organization's goals and objectives. At San Jose State University this philosophy was adopted by the Office of Facilities Development and Operations which is discussed in more detail below.

Information Management at SJSU

Overview of the Present System

Information Management System at San Jose State University is a non-integrated centralized system. Most of the information processing is done on a CDC 830 mainframe while remaining areas have various mini computers such as DEC, PRIME, HP, and very many micro computers. Most of the applications are run in the batch mode and on-line access is not possible. This has created fortresses of information that are not integrated; and access to all necessary information from any location is very cumbersome (Appendix A). As a result of this lack of data access, items of information are duplicated

throughout the campus. This data duplication creates conflicting reports when data is not updated in all systems. The confusion and lack of accuracy has created redundant work for University employees as well as wasting resources.

The same problem exists within the Facilities Development and Operations (FD&O) Office. Presently FD&O has thirty-three PCs and almost thirty of them are networked via a DCA/FOX, 10NET twisted pair Local Area Network (LAN). The LAN provides peer-to-peer communications, electronic mail, electronic calendar, and an electronic bulletin board available to network users. Users can share hard drives, printers, and other I/O (input/output) devices of nodes designated as servers. Communication to the mainframe is done with modems. The main applications packages presently used are:

1. WORDSTAR PROFESSIONAL 5.0 - Wordprocessing
2. DBASE III+ - Database Management
3. LOTUS 2.01 - Spreadsheet
4. GEM PUBLISHER 2.0 - Desktop Publishing
5. GEM DRAW PLUS 2.01 - Drawing and Charts
6. GEM GRAPH - Statistical Graphs
7. EXSYS - Expert System Generator
8. CADVANCE - Computer Aided Design
9. CLIPPER - DBase Program Compiler
10. ORGCHART - Organization Chart Generator
11. HARVARD TOTAL PROJECT MGR. II - Project Org.
12. FACILITIES MANAGEMENT SYSTEM - Energy Mgmt.

There is a Barber-Coleman energy management system which controls most campus buildings. It is a direct digital control (DDC) system consisting of a stand-alone panel in individual buildings that monitor and/or control supply air and outlet air temperatures, static and differential air pressures, start/stop timers, etc. The system is monitored from two locations by IBM-XTs. The communication link is via a 1200 bits per second analog telephone connection which can provide real-time data.

The maintenance management system resides on a PRIME 2655 super mini computer that runs under PRIMOS 20.1 operating system. There are over fifteen terminals for accessing the system. Nearly all communication with the Prime is done through RS-232, which is connected directly via three multiplexers.

Campus work order control and maintenance operations are controlled by a heavily modified version of MPAC from Software Works. This solution is presently used throughout the nineteen campuses of the California State University System. The Maintenance Management System consists of four modules which are Work Order Generation, Inventory Control, Preventive Maintenance, and Purchase Order Generation. Since receiving the packaged solution from the California State University System in early 1987 complete with support, a phased implementation has taken place with a major emphasis on preventive maintenance since early 1988. The biggest bottleneck has been in the gathering of data and having sufficient staff available for an effective implementation.

The Purchasing module has not been implemented due to the Purchasing function utilizing its own system and the MPAC module being a stand-alone package. The forms and numbering system produced by the MPAC MMS are not acceptable to Purchasing.

FD&O maintains the Space and Facilities Database which is the official central record of campus facilities. This provides for control of space assignments, projections of future space needs, and provides data for several state, local, and federal reports. This information is on the CYBER 830 with the Curriculum Data Processing System. This system maintains classroom listings for the purpose of scheduling classes.

The perceived problems associated with separate systems and problems associated with general access to information, plus a maintenance management system which does not provide feedback and status to the campus user community necessitated a requirement for conducting a study and to focus on information needs of FD&O as a key strategic resource.

Recognizing the above problem both at the department level as well as university wide, SJSU philosophy is to move to an integrated administrative information management system. The University received an IBM 3081 mainframe as a donation from the IBM Corporation and the plan is to integrate the necessary functions under the relational database software DB2 on the IBM host. The main administrative system will be the student information, fiscal operations, human resources, and facilities management. In order to be able to eventually integrate FD&O information systems with the

rest of the campus, a joint San Jose State/IBM Application Transfer Study was performed to address these issues within the goals and objectives of FD&O.

Application Transfer Study

The purpose of an Application Transfer Study is to develop a well documented, cost justified recommendation for implementing an application solution to an end user's requirements. This is supported by the end user's management and produced jointly by participants of the end user and IBM. The study is driven by the end user and supported by the Data Processing staff.

The ATS methodology was developed by IBM in response to a need from customers in defining their information systems requirements. The study encompasses an intensive structured joint approach to identify, specify, and justify computer based applications by involving end user managers and computer specialists.

The essential characteristics of the study are:

1. An Executive Sponsor with the responsibility for the business functions to be studied who defines the study scope, appoints the study team, and selects the team members.

2. A combined study team of operational managers, data processing specialists, IBM study team leader, and the local IBM account team systems engineer and/or industry specialist.

3. Carefully defined terms of reference including scope, goals and/or objectives, study schedules, and the study team's commitment is required.

4. A limited time in which to achieve the defined goals/objectives involving full time commitment of all team members of approximately twenty-five to thirty days.

In summary, it is a unique offering and a user driven study and not someone else's study. The basic premise is that the user understands the problems better than any outside group, be that a consulting firm, the MIS organization of a hardware/software vendor.

The ATS scope and objectives for the San Jose State University study were identified during a planning session and further classified through the development of a set of near term tactical and long term strategic goals. It was recognized that the growth of the University over the next decade required a strategic focus to any acceptable systems solution.

The scope and objectives defined for the study are defined in the following chart and supplemented by the tactical and strategic goals.

The information gathering phase of the study consisted of six days of intensive interviews with twenty-eight people from various functional areas within maintenance, general management, purchasing, information systems, and other related functions throughout San Jose State University.

Each person interviewed was asked to identify his or her responsibility and discuss any problems or concerns pertaining to the effective performance of duties, regardless of whether the problems were systems related or not. Also, the interviews focused on any benefits associated with a systems solution.

The study goals and objectives, as well as the ATS process flow, is in the Appendices B & C. The interviews identified 257 problems/needs statements as well as 87 benefit/savings statements. Almost half of the problems identified were related to information system inadequacies which was divided further into forty percent as database related, fifty-five percent as applications related, and five percent balance as hardware related.

System Design:

In order to be able to react quickly to future product requirements and technologies, the system design needed to be feasible and responsive to changing environment. That is why a modular design that can be implemented in incremental steps was recommended. The system design ensures that all users have access to data with flexibility for inquiring and analyzing information in an effective manner to achieve the established goals. Initially to achieve integration, a centralized design on the IBM 3081 hardware with the application that would run on each system was proposed; while in the future migration towards a 9370 distributed design is recommended (Appendix D).

Some of the functional requirements and productivity tools needed to handle, process, and retrieve information are as follows:

Data base management system for creating, updating, and maintaining on-line, centralized, integrated information.

Electronic communications for transferring data and electronic mail.

On-line query capability for extracting information from the on-line data bases and generating customized reports and displays.

Statistical system to permit analyzing information in the on-line data bases.

CAD and Graphics/Text Access capability allowing combined graphics and text access.

On-line, centralized scheduling and space management information for event scheduling and space management planning.

It was also decided that existing systems and applications would be used where possible and incorporate off-the- shelf third party software. To meet these challenges, relational IBM SAA (Systems Application Architecture) products family, namely DB2, AS (Application System), QMF (Query Management Facility), etc., were recommended.

Hardware Solution:

As mentioned earlier, the IBM 3081 mainframe computer will be used initially and an eventual migration to a 9370 distributed system is anticipated. The 9370 system consists of the processor, input/output (I/O) subsystem controllers, the Direct Access Storage Devices (DASD) which can meet commercial as well as intensive computing environments. The 7552 Industrial Computer is proposed as a pilot program for maintaining real time operations, namely building automation and energy management systems. The IBM 5080 Graphics System was recommended as the graphic work station. This unit can respond to interactive design requirements such as three dimensional models, complex surface definition, shaded images, solid models, and

engineering analysis.

The RS-422 communication link was recommended to interface to the mainframe with communication speed of up to 9600 bps. An IBM Token Ring Network that conforms with IEEE 802.5, IEEE 802.2, and ECMA 89 standards was proposed for communication between PCs and PS/2s. The system architecture is shown in the Appendix.

Software Solution:

The major software packages proposed are as follows:

Database 2 (DB2)

DB2 is the state of the art relational database management system. Its structure is based on tables and allows all data in the data base to be dynamically related without having redefined the relationships in the data structure. This feature minimizes redundant data entry.

Application System (AS)

AS is an integrated set of business and data processing tools that assist in the rapid and flexible manipulation of information and presents it in a formatted report. AS also has business graphics support to display information dynamically in histograms, pie charts, tower charts, and maps. It can also provide a variety of statistical analyses, modeling, forecasting, and project management.

Query Management Facility (QMF)

QMF is an interactive query and report writing product which is very easy to use. With QMF, information in a DB2 w84 data base may be accessed, summarized, and formatted into customized reports using easy fill-in blanks panels or charts.

Expert System Environment (ESE)

ESE is an expert system shell designed to build knowledge bases, access data from external procedures and data bases, and prepare custom screens for consultation sessions. It provides the end user with tools to solve problems interactively by asking questions and reaching conclusions.

Computer Aided Design (CADAM)

CADAM is the leading Computer Aided Design/Computer Aided Manufacturing graphics system for the mainframe environment. This will give us the tools to keep the drawings up to date. Along with CADAM, Graphical Display and Query Facility (GDQF) will allow merging graphics with text.

Passport Maintenance Management System

Passport is a maintenance management system that employs DB2 relational database management and adheres to IBM's System Application Architecture (SAA) design guidelines for ease of integration. Passport modules include maintenance activities, maintenance planning, scheduling, supervisory and management activities, inventory control, and purchasing activities.

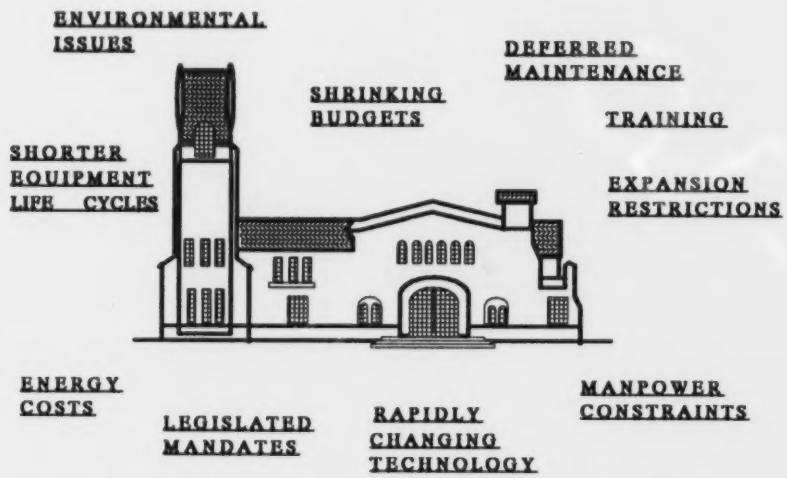
Facilities Management System (FAMM)

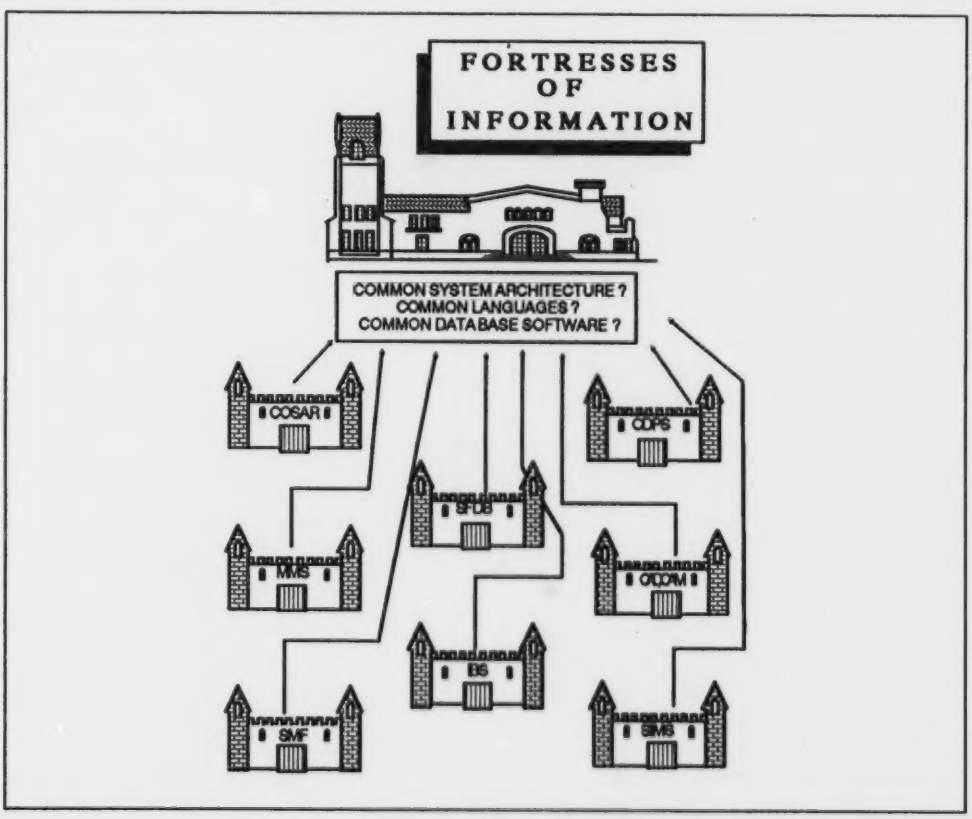
For space management, academic scheduling, and event scheduling, ECAs, FAMM, and classroom scheduling packages will be utilized. This will be integrated with other application packages. Implementing the entire plan is going to take FD&O between three to five years, assuming that required resources will be available (Appendix E).

Concluding Remarks:

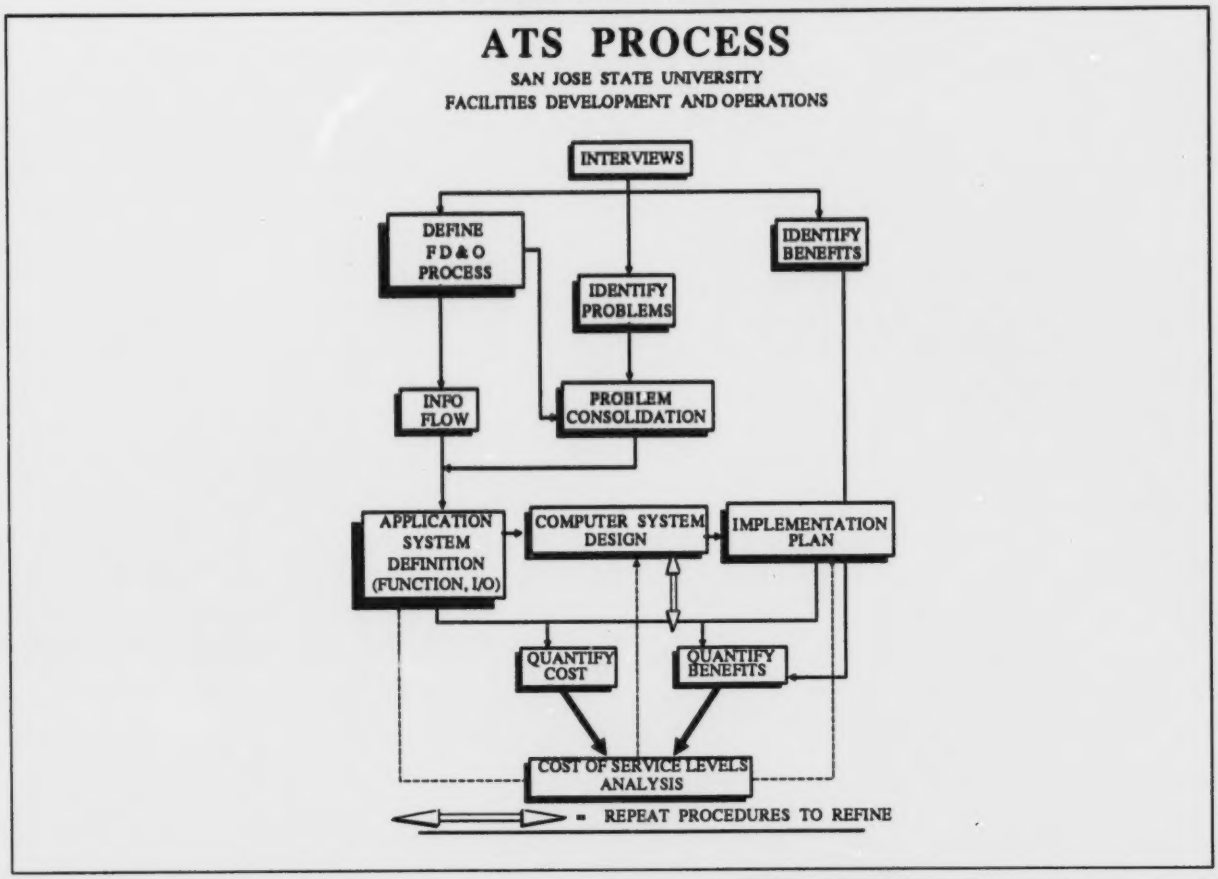
Today for a manager the question is not whether to use computers or not, but rather to optimize their use. The value of information as an organization's resource is being recognized now more than ever before. It is conceivable that in the next century management concern with information resources surpasses the emphasis placed currently on other resources, namely personnel, capital, and machinery. Therefore, information should be managed and shared throughout an organization. Organizations do not operate in isolation and neither can information management. That is why the integrated approach towards information management will be the most meaningful method. That is what the FD&O office at San Jose State University has chosen as a philosophy and belief; time will prove it to be a prudent choice.

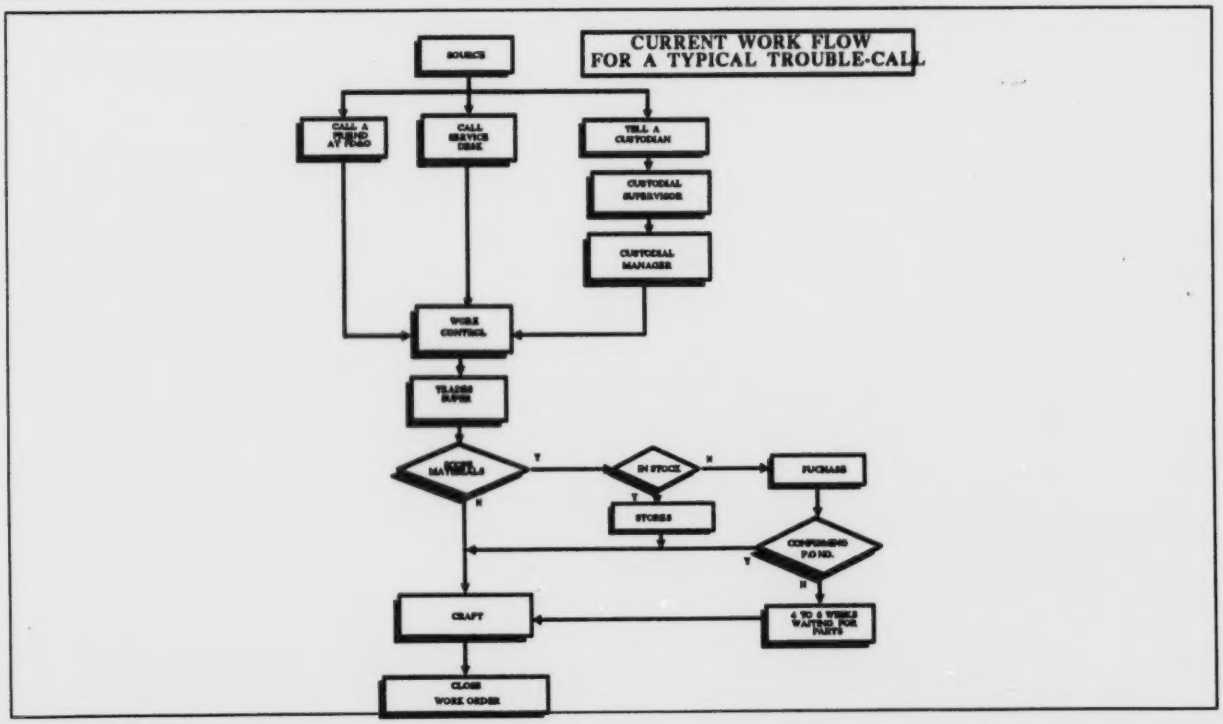
PRESSURES AND CHALLENGES OF FACILITIES DEVELOPMENT AND OPERATIONS





APPENDIX B
ATS PROCESS AND TYPICAL WORKFLOW





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APPENDIX C

ATS PROCESS AND A TYPICAL WORKFLOW

SCOPE AND OBJECTIVES

TO DEVELOP AN INTEGRATED FACILITIES MANAGEMENT INFORMATION SYSTEM.

TO DEVELOP A METHODOLOGY FOR FACILITIES MANAGEMENT LONG RANGE PLANNING WHICH IS CONSISTENT WITH AND DERIVED FROM THE UNIVERSITY'S MISSION.

TO INTEGRATE THE UNIVERSITY'S ACADEMIC MASTER PLAN WITH FACILITIES' MASTER PLAN.

STRATEGIC GOALS

TO DEVELOP A STRATEGY FOR FACILITIES PLANNING, DESIGN/CONSTRUCTION, MAINTENANCE, SPACE MANAGEMENT/SCHEDULING WHICH IS DERIVED FROM THE UNIVERSITY'S LONG RANGE PLAN.

TO DEVELOP FD&O SOLUTIONS WHICH PROVIDE QUALITY, TIMELY, AND RELIABLE INFORMATION TO THE CAMPUS COMMUNITY.

TO ACHIEVE A LEADERSHIP POSITION THROUGH KNOWLEDGE BASED SYSTEMS FOR FACILITIES RELATED APPLICATIONS.

TACTICAL GOALS

TO DEVELOP A DATABASE WITH THE CAPABILITY TO TRACK LABOR AND MATERIALS ON GROUP-I EQUIPMENT AND TO MONITOR COSTS AND SERVICE HISTORY ON A "PER ASSET" BASIS.

TO DEVELOP A METHOD TO OPTIMIZE THE FD&O SYSTEM FOR AUTOMATIC STORES INVENTORY REPLENISHMENT.

TO DEVELOP A SYSTEM THAT HAS CONNECTIVITY WITH EXISTING MANAGEMENT SYSTEM, AS WELL AS OTHER EXISTING CAMPUS SYSTEMS WHOSE DATA MAY BE BENEFICIAL TO FD&O.

TO IMPROVE MAINTENANCE EFFICIENCY AND THE QUALITY OF SERVICE.

TO EFFECTIVELY MANAGE MANPOWER AND THE BACKLOG OF DEFERRED MAINTENANCE PROJECTS.

TO ASSESS THE POTENTIAL OF USING "EXPERT SYSTEMS" SOFTWARE SYSTEM FOR DEVELOPMENT OF A REFERENCE FILE ON CAMPUS MAINTENANCE ACTIVITIES.

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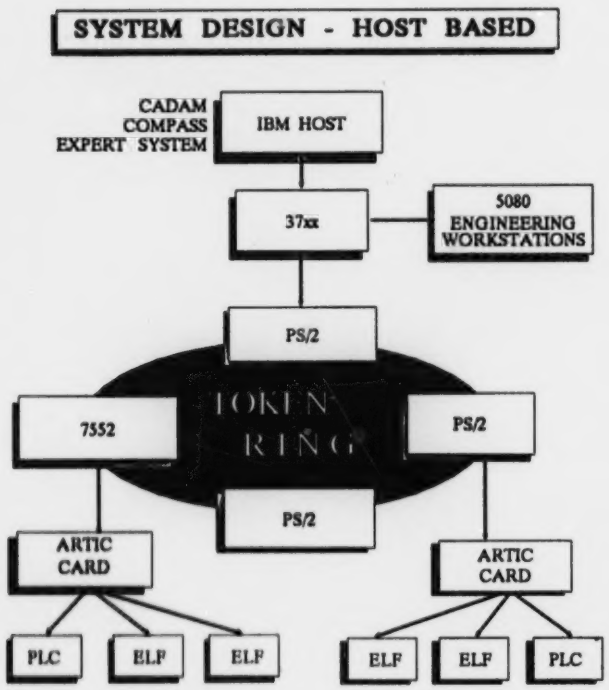
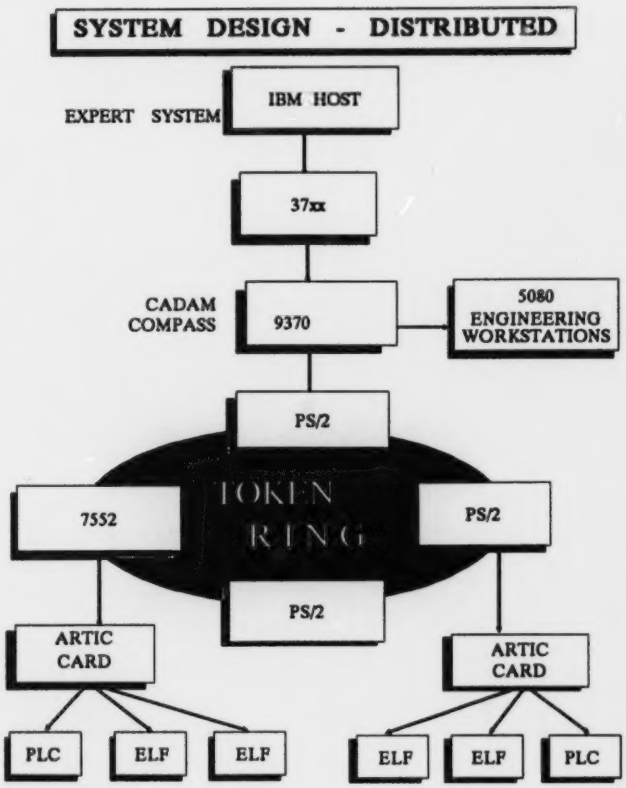
APPENDIX D

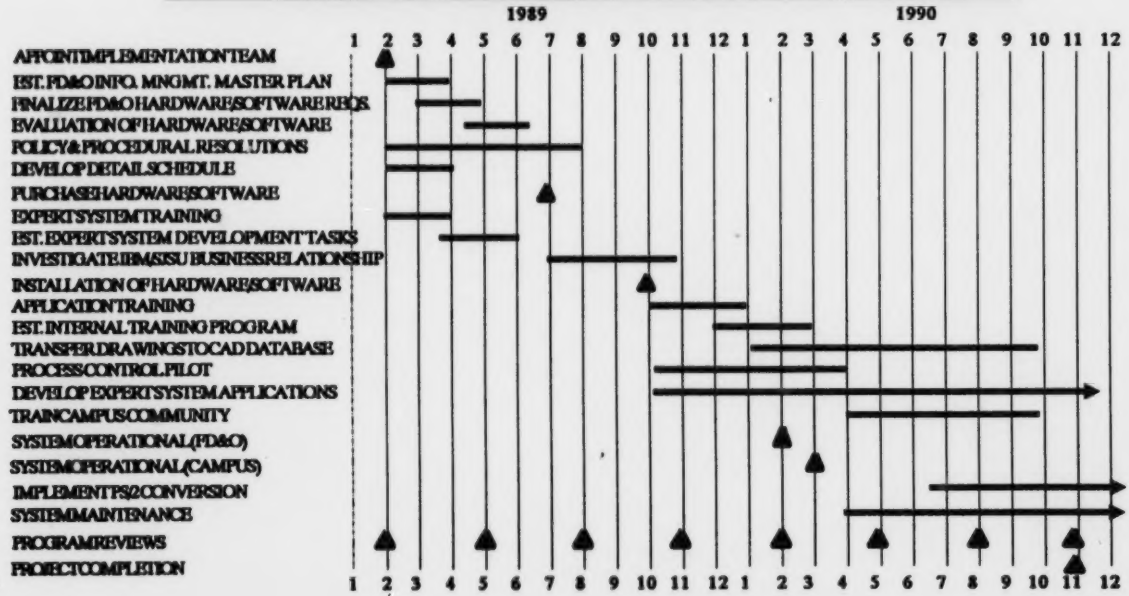
HARDWARE SOLUTIONS





APPENDIX E

FACILITIES DEVELOPMENT AND OPERATIONS FACILITIES INFORMATION MANAGEMENT SYSTEM IMPLEMTATION TIME TABLE


1989
1990
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
APPOINT IMPLEMENTATION TEAM
EST. PD&O INFO. MNG MT. MASTER PLAN
FINALIZE PD&O HARDWARE/SOFTWARE REQS.
EVALUATION OF HARDWARE/SOFTWARE
POLICY & PROCEDURAL RESOLUTIONS
DEVELOP DETAIL SCHEDULE
PURCHASE HARDWARE/SOFTWARE
EXPERT SYSTEM TRAINING
EST. EXPERT SYSTEM DEVELOPMENT TASKS
INVESTIGATE IBM/SISU BUSINESS RELATIONSHIP
INSTALLATION OF HARDWARE/SOFTWARE
APPLICATION TRAINING
EST. INTERNAL TRAINING PROGRAM
TRANSFER DRAWINGS TO CAD DATABASE
PROCESS CONTROL PILOT
DEVELOP EXPERT SYSTEM APPLICATIONS
TRAIN CAMPUS COMMUNITY
SYSTEM OPERATIONAL (PD&O)
SYSTEM OPERATIONAL (CAMPUS)
IMPLEMENT PS/2 CONVERSION
SYSTEM MAINTENANCE
PROGRAM REVIEWS
PROJECT COMPLETION
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12

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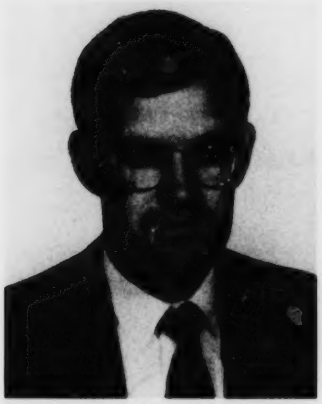

Woods

An Automated Mapping and Facilities Management System

Jim Baker
Management, Computing Services
James Davidson
Facilities Planning
Ben Woods
Manager of Engineering
Texas A&M University

How we have grown! As A&M's enrollment nears 40,000, most recall that day - not long ago - when it passed 30,000. Some remember the 20,000 student era, a few even the 10,000 benchmark. All aspects of the University have grown: enrollment, faculty, staff, and the Physical Plant. It has been suggested that the main sign on Texas Avenue should have a postscript reading "Under Construction". To manage such a large, far-flung, and diverse enterprise, the university has implemented computerized record keeping wherever practical. The payroll is computerized; students locate books in the library using NOTIS and the Student Information Management System (SIMS) tracks the course of 38,000+ students through school and beyond. Similar automated, computerized management systems successfully meet challenges provided by explosive growth and complexity, the press of deadlines, and State and Federal regulations. The need to record and bring order to enormous amounts of information underscores the need for more computerized management.

Systems which streamline record keeping, mapping, tracking and planning functions of facilities and infrastructure management are referred to as Geographic Information System (GIS). While the acronyms are new, such systems perform quite familiar management functions.

The responsibility for planning, constructing, and maintaining the physical facilities at A&M is divided among five main divisions: Physical Plant Department, Facilities Planning and Construction, Planning and Institutional Analysis, Parking and Transportation, and Grounds Maintenance. Each division keeps a set of records, maps and data, but there is much duplication, no set is complete, no set is up-to-date, and a fairly large backlog exists in all divisions. Each area has requirements for a system to map and manage the facilities it oversees. Although divisions share information and assist each other, the existing data management systems are largely holdovers from the era when A&M had 10,000 students and life was much simpler.

For example, maps exist only as paper copies. When a new building is constructed, the mylar base map is altered to reflect the change. The maps, based on old aerial surveys, lack accuracy and cannot be used for detailed design and survey work. Changes made on maps in one division may or may not be made on maps in the archives of other divisions. When one division conducts a survey to locate utilities for new construction, the survey often ends up in a map drawer rather than being circulated to other divisions for verification and improvement of their base maps. Much of the older infrastructure (plumbing lines, chilled water, steam lines, water, sewer, electrical) are only generally located and the exact whereabouts are often unknown. Some divisions do not have ready access to accurate base maps, although they are charged with planning allocation of spatial resources of the campus. The main problems relating to mapping are as follows:

1. Maps are inaccurate and out of date.
2. No complete maps of the infrastructure exist.
3. No coordinated map update and verification practices are in place.

4. There is no tie between maps and databases.
5. New maps must be drawn by hand, making it tedious and expensive to produce maps of differing scales or special maps showing only selected areas or utilities. Outside of the Computing Services Center, no automated mapping exists, although some groups are looking into the technology.
6. Maps have no ties to Computer Aided Design & Drafting (CADD) programs.
7. There is a significant backlog of buildings and utilities which need to be added to the maps.
8. There are no accurate base maps for landscape maintenance of the vegetation and irrigation systems.
9. There are no links between computerized databases maintained by Planning and Institutional Analysis and any mapping system.

While mapping is an important aspect of managing facilities, it is only part of the picture. Managing information is far more important and offers the greatest rewards. The need exists to create a computerized database to organize, store, and access information such as: the date of construction, expected life, materials, installed costs, repair history and contractor. Another example would be electrical transformers -- including maintenance schedules, rating of the device, manufacturer, PCB status, what lines and buildings are dependent upon each transformer. Knowledge of the location of asbestos, radioactive materials, hazardous chemicals, or explosives on campus has become increasingly important. Information on the repair and maintenance history of the facilities, space allocation records and even information regarding species and treatment schedules for trees and shrubs are viable database elements. The list is long, but state and federal auditors expect A&M to access and provide pertinent information when justifying expenditures for new construction or maintenance.

Such information should provide the basis for managing the campus facilities, planning maintenance and projecting future needs. Stacks of paper maps and file

cabinets once sufficed as information management systems, but we have outgrown that era. Included in the GIS system are ways of managing data with the aid of the computer. When data is systematically stored on a computer we call the result a database. Database technology has evolved over the years from simple lists, to the present where databases are capable of responding to English-like commands and questions. Modern relational databases can provide responses to inquiries such as "List all of the facilities which have classroom capacity of over 50 students and are located on the West Campus. Relational databases can provide executives with the ability to ask new questions and furnish answers to management quickly and accurately. These are the real advantages of modern relational databases.

Another benefit of computerized databases derives from the ability of many divisions, located in different buildings, to share the same database. Each division updates layers of data for which they are responsible. Layers might be comprised of plumbing lines, parking lots, sidewalks, the 4th floor plan of Rudder Tower, or event the locations and species of trees on campus. In a GIS system, a link exists between the database and automated mapping capabilities, allowing the mapping program to access the latest version of data, therefore, each time a map is plotted, it is based upon the latest data. A&M's divisions can select whichever subset of the database they need and be assured it contains the most accurate, up-to-date information. Divisions can also implement security schemes which will lock others out of sensitive information.

Of the mapping related problems listed previously, an Automated Mapping/Facilities Management system (AM/FM) could significantly reduce all but one: the backlog of unrecorded data. The "catch-up" or "scrub" needed to bring our records up-to-date must be accomplished by hard work. Personnel must go into the field to locate and record the lines. Data must be collected and entered into the computer to create databases. Existing databases must be converted into a common format.

What is the payoff for all the work, all the expense?

- A GIS system would provide extensive map storage, analysis and display capabilities.
- It would provide the ability to produce detailed maps for maintenance personnel.
- Maps could be updated easily.
- Maps could be produced quickly, on demand, and at much less expense than hand drawn maps.
- The system would allow users to window part of a map, and to produce a map only of the desired, windowed area.
- Maps of any scale could be produced.
- Users would have the ability to select which layers of information they wished to include in a map. For example, a map might be needed which would show only the water lines which run in the steam tunnels on main campus, or a map showing only the parking lots and streets.
- There would be a system available which is easy to learn, use and operate.
- The GIS system would have the ability to utilize Computer Aided Design and Drafting (CADD).
- The system could perform 3 dimensional modeling and simulation and allow planners to see what a building would look like on a site before it was built.
- The system would run on local, low cost, multipurpose computers capable of performing other tasks such as spreadsheet analysis, electronic publishing, and presentation graphics.
- With a GIS system in place, obtaining timely, accurate information becomes easier and more efficient.
- Professionals from different divisions could access the database.
- For long-term planning, such a system facilitates the creation of maintenance schedules.

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- Such a system allows management to ask questions of the database: "If we put a building here, what utilities will have to be rerouted?" Management could perform "What If..." planning scenarios more easily.
- A&M would have a system which could expand with the needs of the University.
- Eventually, the effort required to get existing records up-to-date will have to be expended. The process of GIS implementation will help divisions reduce current backlogs of changes resulting in the first comprehensive, up-to-date map of A&M lands, facilities and utilities.
- The hardware and software configuration selected offers a relatively low-cost solution.
- Overall, GIS technology offers a means to improve productivity and decision support for a wide range of management applications.

What are the components of a GIS system? Of course, there must be hardware: a computer -- it can be almost any type from a mainframe to a microcomputer; a digitizer and plotter; a large hard disk for data storage; and a high resolution color monitor to preview maps. Software will consist of a number of components: a relational database management system for storage, retrieval and manipulation of data; a user interface for program access without the need for years of programming experience; a mapping/computer aided design package to perform drawing and design functions; and application packages to facilitate work order generation, engineering analysis and other applications. These four components are offered by an increasing field of vendors. Much time and energy has gone into assessing the relative strengths and weaknesses of the leaders in GIS products. But the hardware/software does not work by itself. One more component to be considered is the operational component. The system requires people and a place for doing the work. The people must have familiarity with both computing and the facilities and infrastructure of A&M. At least initially, a central location will be

required to house the implementation team which will convert existing data and maps and input information in the GIS system.

During the Spring and Summer of 1988, the leading GIS vendors were invited to come to A&M and present their products. Participants included ERSI, GeoVision, Intergraph, CAD Associates, Earth One, IBM, Holguin, and Generation 5. On other occasions, TerraMar, Synercom, and the public domain packages GRASS and SAGIS were viewed. Criteria for judging the companies were established early. The system has to have the capability of multiple users sharing the database over the campus Fiberoptic network. It has to be user-friendly, we want to avoid a system which is so complex that training takes years, or cannot be implemented without hiring specialists. A positive value is placed on systems using non-proprietary hardware. When a system uses hardware which is not "off-the-shelf" it is harder and more expensive to get repaired, to find operators, and stay abreast of improvements in technology. Since relational database technology has become the state-of-the-art, we would require that this system fully implement one of the more popular relational databases. Since cost is a major consideration, we gave credit to those vendors with more affordable systems. Functionability, the ability to do many tasks, was another consideration. The availability of support, advanced applications software and size of the installed user base was also studied.

Because of the complexity of the project, a central management team should coordinate the project throughout. The team would consist of a project manager, a data conversion specialist, and a system specialist. Under the recommended plan three additional field personnel would be required during the conversion process. After conversion is complete the data conversion specialist and three field personnel would join the main user groups. The Project Manager and the computer specialist would continue to administer the AGIS system as a part of the CSC or another part of the University.

The conversion of existing maps, data and other information sources represents a monumental task. The process of catching up and updating existing maps is called "scrub", indicative of the scrubbing which must be done before the documents are suitable for conversion.

What is involved in the conversion process? Converting data into digital forms suitable for storage in a computer system requires that all of the points or lines on a map be assigned x and y coordinates, a process called digitization. Each line must have characteristics associated with the line -- does it represent a water main, an electrical power line or a building outline. The conversion process is a tedious, time consuming effort which will involve the digitization of well over a thousand maps and floor plans, and creation of a very large database. Another major component of the conversion task will be the aerial flyover and subsequent digitization of photographs produced. An accurate base map will rely heavily on results of the aerial flyover to be successful, a great deal of preparation must precede the actual flight. A system of ground control must be set on campus to provide accurate survey control. Manholes and other important features should be painted to allow easy identification during the digitizing and database phase.

Once an accurate base map has been completed, a pilot project will be conducted in two select areas to test the system implementation and refine cost estimates. Conversion of all utilities, building floor plans, landscape and other desired features will be completed for the pilot areas. Upon successful completion of the pilot project, full scale conversions will begin for the entire campus.

The costs of AGIS for a 4 year implementation scenario is estimated at $2,848,900 through 1992. Much of the cost represents expenditures to update current records. The schedule provides a fully implemented system quickly so each division would be able to realize benefits at the earliest possible time.

STATEMENT OF NEED

"Is accurate, consistent base data important?" "Do we need the corporate knowledge of what physically makes up our universities?"

If the answers to those questions is no, then there is no reason to proceed any further. As users and managers of the geographically related assets of our institutions, our answers to those questions is that it is not only needed it is essential. That theme is central to the discussion of GIS.

GIS is not an end unto itself. It is merely a tool. However, it is a powerful tool which allows for the more efficient accomplishment of tasks currently required and the realization of potential from accomplishment of tasks not currently feasible.

The needs of the University fall into three broad categories:

Automated Mapping

Automated mapping refers to the utilization of computer technology to track and draw geographically related data. This technology allows for storage of spatial information in a database which can be called upon as required. The computer allows for continuous integrity of spatial data with the ability to manipulate that data to meet user requirements.

Facilities Management

Automated record keeping of various geocoded elements of the geographically related database allows for management of those assets. The tabular, descriptive data which covers attributes of the spatial data sets has, until now, not been manageable concurrent with updates, revisions or acquisition of the mapping data. The need exists to tie descriptive data to spatial data and to do so in an interactive way.

Interaction

There are many organizations which interact with the geographically related data within the university community and need an automated process to update and read a

common database. This database is best represented by a central storehouse for information. Each independent user views common information. The end result is consolidation of effort to the creation of a more accurate, current database.

EXISTING DATA AND SYSTEMS

The University currently generates a tremendous amount of geographically related data. There are literally thousands of sheets of drawings and maps which tell users what and where something is located. Or do they? There are several problems with the existing system for acquisition and compilation of data. Most of these concern mapping related activities. All are driving forces behind the implementation of AGIS.

Data Formats

There is currently no integration between the mapping/drawing function and the facilities management function which allow them to work hand-in-hand. As has been stated, there are countless hand drawn maps available. There are also some computer generated tabular products available. Correlating the two is a tedious manual task.

Mapping

Campus maps have evolved over the years in an attempt to meet demands generated by expansive growth of the University. As certain milestones were reached, the decision was made to update the landbase through use of aerial photography. Unfortunately, this landbase was drawn at a different scale each time it was flown. A major remapping of the campus was undertaken in the mid 50's, and many of the current utility maps are drawn on base maps from that era which have been updated by hand over the years. The medium and methods used created problems. Drafting mediums have certain inherent difficulties. These have to do with loss of scale due to stretch and deterioration of the medium. A major problem also results when many base maps are required of any one particular area. For example, if you were to choose any one particular building, that facility is shown on as many as 10 maps. Each map has a unique

need and function. Any time that facility is updated or altered there are at least 10 maps affected.

Besides problems associated with the medium, the method of maintaining these maps tends to create inaccurate data due to the human error built into a system dependent upon multiple entries of any one component.

The following figures give some impression of the size of the tasks we are dealing with at this time:

- Over 80 campus utility maps at various scales.
- Over 302 field survey utility drawings accomplished by Facilities Planning over the last ten years.
- About 700 map drawings of campus landscape features.
- About 500 map type drawings of record site plans from recent construction plans.
- Several sets of "base data" (general layout) maps available from flyovers. In 1984, 1" = 50' flyovers were accomplished of the west campus. In 1977, 1" = 100'/200' flyovers were accomplished for the entire "developed campus".

Building Plans

Due to the vast amount of data and cost of conversion of that data, there are initial feasibility limits for AGIS. The intent with regard to building plans is to capture floor plan information only. Original floor plans are available from Facilities Planning and Construction which are made up of approximately 825 plan drawings at various scales. These represent the "as-built" layout at acceptance of construction and do not represent actual present conditions in most older buildings (the issue of accuracy and currency will be discussed in depth later). The building plans, therefore, represent a large segment of the data to be captured and have varying degrees of accuracy. There is no plan at this time to capture any information other than exterior footprint, interior wall locations, doors, windows and room number assignments.

Computer Print Outs

There are many requirements for the University to quantify its assets. The development of maintenance appropriations for both Physical Plant and Grounds Maintenance and the development of space utilization reports for both internal and Coordinating Board requirements are just a few of the major ones. These numbers are currently generated by various departments. Hopefully they are accurate. In most cases, these are quantities generated by hand. The existing systems therefore represent the beginnings of a database. The problems are simple. The data which is gathered from the map and plan formats previously mentioned cannot be linked to computer database sources in any manner short of manual manipulation. The relationship is a difficult and tedious one to keep in balance.

These data formats represent the three major areas which exist and serve a needed purpose. There are, however, serious limitations to these formats and to the data itself.

Currency and Accuracy

The existing data are, for the most part, neither current nor accurate. The currency of the data reflects several events which have occurred over the past years. First, the campus has experienced continuous and rapid growth. Attempts at updating have been hampered almost from the beginning by the problem of data format. For example, as a new building came on line there were many maps which required updating. Tasks were continuously piling up and creating a backlog which today is estimated at over 5+ man years. Secondly, the medium by which data were recorded resulted in real problems. The lack of any campus grid or coordinate system created problems and still does today. Data input was done by hand had inherent inaccuracies built in from the start. The paper medium was always subject to stretch and deterioration. Each redrawing of the base data magnified existing accuracies. Thirdly, expansion of the campus to the west generated the need for more maps covering greater geographic areas. Maps prepared in the 50's and 60's no longer served to depict the total picture.

Accuracy is a relative term. The previous surveys are relatively accurate. The problem is how to tie surveys together to look at the total picture. Therefore, the accuracy of the picture is limited because only a portion of the view is seen at any one time. Different data sources reflect different accuracies. The utility maps drawings on 1957 base data, which has been hand updated, are considered to be schematic as opposed to geographic. In other words, they indicate which utilities are there, not where the utilities are in fact located. The building floor plans which exist for the CE/TTI Building (a recently constructed facility) are current and accurate with the exception of walls already relocated by the Physical Plant due to changing user requirements. Existing floor plans for the System Administration Building (a very old building with modifications too numerous to count) are very out of date and do not depict current status for parts of the building.

Redundancy and Duplication

Each major organization with responsibilities requiring use of this geographic data must maintain its own database in the forms of maps, drawings, etc. The inability to effectively transmit inputs to a single unified database has created redundancy and duplication. For new construction, accurate surveys are performed by Facilities Planning. After the survey is drawn, that information must again be redrawn on the multitude of base maps maintained by Physical Plant and Grounds Maintenance. The information is then added to utility or landscaping maps. If these data are not transmitted to other departments, they may simply go into a drawer in the file vault and the real value never realized. Redundancy in turn leads to departmental maps which do not match maps in other departments. The prime example is the year-long effort required to insure that square foot figures used for maintenance funding matches space figures sent to the Coordinating Board.

Current data are largely inaccurate. The methodology and tools being utilized today contribute to that inaccuracy. The many organizations which impact on these data also contribute to that inaccuracy. The existing data are not current. A large backlog exists of data to be field verified. Therefore, prior to input of data into AGIS, a tremendous "scrub" effort will be required. This effort will determine the viability of the output from AGIS and the foundation upon which future data will reside. The scrub effort needs to be undertaken to get current records in an acceptable form, and that effort will have to be expanded regardless of whether AGIS is adopted or not.

WHAT IS A GEOGRAPHIC INFORMATION SYSTEM

A Geographic Information System, a tool for decision making and an aid for planning and development, consists of a database containing spatially referenced, land-related data as well as procedures for collecting, updating, and distributing that data. The fundamental base of a GIS is a uniform scheme for data referencing, which enables data within the system to be readily linked with other land related data. It must integrate modern principles of software engineering, database management and mapping theory.

The evolution of computers has led to the development of automated systems for the handling, storage and transfer of information. There is a rapidly expanding technology for the conversion from manual to automatic methods for handling of geographic information systems. This technology has experienced a quantum leap since the early 70's. The emergence of more sophisticated computer technologies such as relational database management systems, mini-computers, workstations and increasingly cost effective CPU processing power has resulted in a growing interest in automated geographic information management at nearly every level of industry and government.

The GIS takes land related data in the form of maps and allows the assignment of attributes. The GIS then permits manipulation of this combined database to develop answers to queries or analysis of planned or existing conditions. The role of the GIS is to bring together the corporate knowledge of the physical entity which makes up the

internal and external plant of bricks, concrete, steel, glass, pipes, landscaping, utilization. Through the aid of GIS, the goal is to make that knowledge base readily available to those whose professions are dedicated to the efficient management and development of these assets.

A Geographic Information System is comprised of five fundamental elements:

1. Selected "data" about geographic locations
2. The "software" to manipulate and manage this data
3. The "hardware" upon which the data and software reside
4. The "people" responsible for overseeing GIS operations
5. The "procedures" for using and maintaining the GIS

GIS Data

GIS data include both spatial data and descriptive data.

Spatial data provide visual information about shape and location as well as relationships among various geographic features. The mapping and floor plan data inform the University where its physical assets are located and how they relate to each other. The integration of a uniform coordinate system enables this information to be digitized and captured into this knowledge base in such a manner that it can be stored and manipulated by the computer. This information may represent points, lines, polygons or surfaces. Each of these enable information to be interrelated as required by the physical attributes related to the asset in question. A point is used to represent an item such as a valve, manhole, plant or any singular feature tied to one coordinate location. A line is used to represent an item such as a pipe, wall or any linear collection of points. A polygon represents any collection of points with homogeneous characteristics such as parking lots, building floor plans, space utilization, planters, or assigned space. Surface data represents a three dimensional collection of points which have area, length, volume or other measurable attributes. The term "topology" refers to the manner in which these data collections are linked together. While this may be visually explicit on a map, the database must have the ability to reference and manipulate this in a digital format.

Descriptive data refer to that collection of attribute data which describe the spatial data. These data have historically been of a tabular nature and while we instinctively associate them with geographic entities, the GIS enables the natural association and manipulation of these two data types automatically. Descriptive data may include forms, lists, counts, measurements or graphic annotation. Examples are type of material, age of material, costs associated with entities, utilization rates, or history.

Together these collections form the "Geographical Database". This in turn is then available to multiple users on an as needed basis.

GIS Software

GIS is often thought of as a tool for putting maps into a computer and performing various types of map overlay analyses. However, the true value to the user is evident when the data collection become the basis for improved management of the assets. With access to GIS software tools this collection of data are now available for mathematical analyses, producing maps and reports and flexible response to ad hoc queries. It also provides a common knowledge base to consolidate the reference as to what physically makes up Texas A&M University.

Software must therefore provide four major functions:

1. Data entry
2. Data analysis
3. Data output and display
4. Data management

GIS Hardware

GIS hardware consists of various devices which enable software functions to be carried out. These include data entry and output devices as well as the central processing unit capability. Historically, data entry devices have included digitizers, scanners and desktop workstations. A workstation combines a high resolution interactive graphic screen with distributed processing capability. Display and output devices typically include plotters, printers and graphic and alphanumeric terminals.

GIS People

It is the people who develop, implement and manage this tool to provide the output which in turn benefits and increases management capabilities. The organization in which the system will function is more vital to success of the system than other fundamental elements. The dedicated effort of personnel knowledgeable in management, database acquisition, database management, and application development is essential. The scope of the effort is such that unless the effort is seen for what it really is -- a long term dedication to a concept of a central knowledge bank which is implemented and maintained -- the system will be doomed from the start.

GIS Procedures

An administrative structure is a mandatory part of the GIS. It consists of a set of procedures and protocols that are designed to enable various users to effectively communicate for GIS oversight and management. Because of the number of users which will need to interact with AGIS, it is essential that the system be viewed as a University resource and not the exclusive responsibility or property of any one particular user. The tool provided is one needed by a wide array of University personnel. The central theme to implementation of such a system is to integrate all agencies and departments which have need for these data so it can be designed for maximization of benefit.

THE AGIS DEVELOPMENT CYCLE

The AGIS development cycle is a chronological sequence of tasks and events which culminates in the completed implementation of an operational tool for enhanced management of Texas A&M University. Following is a brief discussion of necessary stages. This is the roadmap which we are currently using and will lead to the objective of a working GIS System.

Feasibility Study

An initial step was to consider the feasibility of undertaking the development of AGIS. For the past 16 months, members of the Ad Hoc Committee have been studying the existing technology and developing a concept of how such technology might be applied to meet needs of the University.

Organizational Factors

The course of the feasibility study led to an evaluation of the organization in which AGIS must operate. The evaluation established criteria for the management structure.

User Requirement Analysis

The identification of potential users for AGIS and the respective functions they perform was developed with specific attention paid to types of geographically related data with which each is involved.

Existing Data and Systems

The examination of existing data sources confirmed the general condition of campus mapping and knowledge of infrastructure. The current state of affairs is primarily related to the methods and medium being utilized.

System Design

Involves the evolution of the conceptual design of the total system which integrates organization, database, hardware, software and procedures.

Planning for Implementation

Outlines transition from the feasibility stage to the actual establishment of a plan for the implementation of AGIS.

Detailed Implementation Plan

Outlines the detailed planning which is required and accomplished during the first six months of implementation. This occurs after the implementation team is in place.

System Acquisition

Involves the acquisition of the hardware/software for AGIS.

Data Conversion

Involves the process by which the data are acquired, fields verified and prepared into the proper formats for entry into the database.

CONCLUSION

There are times in the affairs of an enterprise when technological progress offers unprecedented opportunities: the performance of old tasks more efficiently and effectively; preparation for future growth and expansion of capabilities; and many more opportunities to move forward with purpose. Texas A&M finds itself at such a crossroad as many other campuses do. Rapid expansion of A&M's physical plant has brought the campus to the size of a small city. The infrastructure which supports the campus must be monitored, mapped, and understood by divisions which bear responsibility for the successful operation of A&M. Fortunately, computerized mapping and database technology have evolved to a point where affordable solutions exist to solve the problems which face Texas A&M University. The technology and implementation has costs associated, but those costs are less than those of inaction, and the benefits are substantial.

TRACKER: A Data Entry and Reporting System

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TRACKER provides a system to streamline tasks previously performed manually. TRACKER is a computer program, developed in-house, that accepts data entry and provides analysis of utility use and cost (tracking), by meter, for all components of Kansas State University (KSU). A wide variety of metering is encompassed, including natural gas, electricity, condensate, and energy flow (Btu). These include auxiliary enterprise meters (Housing, Student Union, etc.) and off-site meters serving Agriculture Experiment stations located throughout Kansas. Input of daily boiler, chiller and other operating data allows TRACKER to produce monthly costs for production of steam and chilled water. TRACKER produces monthly predictions of utility use and cost for all meters, based on current use, cost, and weather data.

The program operates on MS-DOS (1) compatible computers. The development of the system provides data portability between most existing and future personal computers, and many larger machines. This feature helps protect labor invested in the data base.

This paper has two purposes:

1. Discuss the capabilities of the utility tracking program.

2. Discuss the logic used during the development of this program. Even if you already have a utility tracking system in place, a review of the thought process used to develop this software may provide some insight on ways of improving future programs. Hopefully, too, you can help spot flaws in this system. (While this paper attempts to describe program development in an orderly fashion, the reader should note that the actual process is more parallel than serial, with several pieces of the puzzle developed simultaneously.)

Need for System

The KSU Power Plant has a variety of responsibilities. These include production of chilled water, steam, electricity, monitoring of campus utilities, and the record keeping associated with this work. Part of the record keeping function includes preparation of annual estimates of utility costs for the upcoming fiscal year. This calculation is based, in essence, on an historic data base.

Another record keeping function is verification of bills received monthly from various utility companies, which includes verifying that the proper rate has been properly applied, and that reported unit consumption is reasonable. In addition, Power Plant gathers readings from various campus submeters. This accumulated data is used monthly to distribute utility costs for each of the University's components (at KSU, these are: academic and administrative functions; College of Veterinary Medicine {a separately funded operation}; and such auxiliary enterprises as Student Housing, Student Union, etc.).

Reports are produced monthly which compare actual billing data with the appropriate portion of the annual estimate. Using current data and updated projections, the annual total utility estimate is updated and compared with the legislative appropriation. The legislative process requires prompt notification should the appropriation differ significantly from need. An additional output of this process is the monthly operations report, which shows energy flows to various campus functions (process steam, chilled water, etc.)

A hand calculation system had been successfully operated for many years. The addition of new research buildings, addition of a significant quantity of off-site meters, and changes in administrative needs threatened to overwhelm existing methods (that is, the data base access time was too great). The need for a faster method of analysis and data access suggested converting to a computerized tracking system. Necessity is the mother of invention and computer programs.

First consideration was given to adding the tracking system to Facilities Management's accounting system, a mid-range minicomputer. However, a commitment to upgrade this system had back logged software development approximately two years. Consideration was then given to using a microcomputer. The volume of calculations required could easily be handled on current low-end equipment.

The quickest implementation of a computerized system would be to purchase packaged utility tracking software from a vendor. A review of available packages suggested two potential problems for this particular application: lack of flexibility, and lack of portability. Considering the amount of time required to convert the existing paper data base to electronic storage, and considering the advances (and obsolescence) that have occurred in computer hardware in this decade, a decision was made to not use packaged utility tracking programs. Thus, the potential for file size limitations are minimized. By careful development of a custom software system, portability of the data base between computers can be better protected.

Custom software development could be provided from either in-house personnel, or by outside contractors. Little useful information can be provided here, because budget concerns prevented consideration of program development by outside contractors.

Logically, program development, even for micros, should be conducted by staff programmers. Again, prior commitments restricted this option. Both data entry and program development

responsibility fell to Power Plant personnel.

System Requirements

As with any system, the simpler it is to operate, the better its chances for success. However, this simple system must be complex enough to produce the desired information. It must be able to access and compare data for present and past periods so that the annual utility estimates can be made. While few care about the past, everybody wants to know about the future, so that proper plans can be made. Various tools, such as electrical growth trends, weather trends, and student growth trends are useful for both short and long term planning.

We required the system have the capability of data review on a per meter basis, not just as a conglomerate. Predictions can thus be made on a per meter basis, which allows better tracking of individual building changes, and can help pinpoint significant differences between actual and projected values. We required the system to produce the value of plant output. In this way, we could quickly determine both operating costs and value added.

Software Selection

Using a microcomputer provides many advantages, including multiple methods of solving any particular problem. Having outlined what the system should do, another decision has to be made: What should the software base be? Each software group offers unique strengths and weaknesses. Spreadsheet programs offer good on-screen flexibility, lots of functions, graphics capabilities, good use of hardware capabilities, built-in help screens, easy format generation and testing of formula and assumptions. They also provide "instant gratification." This implies that as soon as a change is made, the results can be seen, which is a good debugging tool. However, they offer limited and clumsy data base capabilities, i.e. slower for large data files, easy to build in mistakes, and it is hard to build error traps (discussed later). They also can limit the possibility of portability between computers.

Programming languages, such as BASIC and Pascal, offer a different set of advantages and disadvantages. They offer the best flexibility in that program writers control their own destiny. They have less size limitations, error traps can be developed, they offer good speed, and some languages offer "instant gratification". However, some languages must go through a time consuming compiling process before each new test. Disk access is more difficult than using a spreadsheet program. Any output filters (discussed later) must be developed by the programmer.

Data base programs offer a middle ground for a program writer. They offer good flexibility, little size limitations, good portability in some systems, can develop traps, have good speed, and can provide "instant gratification". Some can be compiled at a later time, after all testing has been completed. In this way, they can offer quicker system development, and faster operating speeds. They also provide simple data access (which is the hardest part of program development), and access to existing output filters.

Use of a program language requires that the programmer develop all the necessary data access routines, while these are built into spreadsheet and data base program. Use of a spreadsheet requires that sufficient RAM (3)(4) be available to contain the entire data base while programming languages and data base programs retrieve only the selected data from floppy or

hard disk storage. It was decided that the simplest development would be by using a data base program.

Using this logic, TRACKER was developed using dBase III Plus (1). This program was primarily chosen due to its familiarity to a large group of programmers. Current versions of dBase are written in the C programming language, a machine independent language. This means that programs written on a personal computer can be run, with only minor revision, on mini, mainframe, or super computers. (This is not meant to imply that other data base programs lack similar capabilities.) Using such software simplifies adding future hardware improvements, such as input/output to CD-ROM.

Data Base Definitions

The data needed to complete the outlined tasks was identified and this information was used to define the data base, or data bases. The meter master data base contains the origination data for each meter, including: locations, utility company or KSU delivery, meter number, account number (if applicable), what campus division is responsible for payment, what type of utility is involved, meter constant, and rate number. Rate schedule data is stored separately.

The monthly meter data base contains meter numbers, account numbers (if applicable), meter readings, and amount charged. The meter data base varies by utility type. For example, the water meter data base requires less monthly data (quantity used) than the larger electrical data base (power factor, maximum demand, quantity used). A single data base was originally defined to store all utility data, but this was abandoned in favor of multiple data bases for each type of utility. This improves system flexibility and improves speed of operation. Power Plant daily log data base was also created to contain steam flow, electrical generation, fuel use, labor cost, and other data that would be used to determine value added.

Once the data base(s) is defined, the task becomes how to best deal with the data.

Program Development

A major component of computer software is the user interface, that is, what actions the user must perform in order to produce the desired result. The spreadsheet interface (first seen in VisiCalc (1), later used in the 1-2-3 (1) program) was among the first systems that allowed full screen cursor movement on a microcomputer. Apple (1) has successfully implemented a graphical user interface in its Macintosh (1) systems. Microsoft (1), IBM (1) and others are currently marketing similar systems. The success of such systems is due to getting the user to feel comfortable with using a computer, and quickly learning the skills necessary to access information.

Effort put into a friendly user interface pays dividends by improving efficiency of teaching and bringing new employees "up to speed" quicker. KSU Power Plant employees are hired for their mechanical abilities, not their computer or typing skills (2). In addition, students are employed for power plant clerical work, which implies a regular turn over of personnel. New clerical personnel require training, not only in computer operation, but in power plant operation. Providing an easily used system is mandatory; a difficult system is doomed to failure. Thus, a decision was made to build a menu driven system, using cursor keys for the majority of menu selections. While this requires additional programming, training time is shortened.

Systems design must consider speed of operation. Even a good interface is not useful if it operates slowly. A system design that minimizes steps in each completed task will operate at a faster speed. This implies use of program modules, or subprograms. The initial user screen(s) is one stand-alone program, as are other portions of the system. Program development using modules simplifies trouble shooting because each function is independent of other program components. Using program modules also simplifies the task of adding future capabilities, by reducing disruptions to the functioning system. Breaking up programming into multiple modules (instead of one long program) also allows development by multiple programmers. Potentially, modules developed for a particular task (such as the user interface or report generator) could be stored as a library to be used by other programmers as a basis for future projects.

Utility data, or any other data base, requires accurate entry in order to be useful. Recalling the maxim "garbage in, garbage out", a system for error checking and correction is required. Development of efficient error traps and filters requires knowledge of the data to be entered so that errors can be anticipated, and their occupance can be properly handled. It also requires knowledge of who will use the program, of the "standard person". Using this philosophy, a dual entry filter was designed, requiring that all data be entered twice, into a temporary file.

This is acceptable when adding a single meter, or a new building to the data base. However, the dual entry process becomes tedious when entering a stack of monthly utility bills (a typical KSU electrical account number is 320121-9705390, water meter is 2146-6456-900). To speed entry of these numbers, a "wild card" character (*) was used. The data filter allows entry of either the entire number, or the wild card and only four digits (*5390 for electric, *6456* for water). Only meter and account numbers allow the wild card character.

The temporary file is then sorted, which matches pairs of data that should be identical. If comparison shows that the pairs are not identical, the user makes corrections until the data does match using the dBase Edit System. After comparison shows all data pairs match exactly, every other data entry is erased and the wild card character is stripped. The account or meter numbers are then compared to those of the meter master file. If there is no match between the entire number (or the partial number), the user is required to correct the data. For KSU-supplied utilities, the review is complete. For purchased utilities, the program enters the meter reading(s) into the stored rate schedule, and the calculated amount is compared to the billed amount. Any discrepancy requires correction of either the data, or the rate schedule. When the data passes all the quality checks, the temporary file is then appended to the appropriate meter data file.

Program development is similar to most Facilities Management functions: very few are concerned with how things get done, but many want to see the results. Regardless of how rapid or elegant the user interface is, or how well the error traps work, the program function that concerns others is the report generator. This is, after all, the main reason to develop this or any other program. The report generator must be able to create, store and use formats, and provide useful data in reasonable time. It must be flexible enough to support canned reports but also be able to generate and output query results, must be able to alert user of data limits (not all bills have arrived, data outside expected range, etc.), and must generate exception reports (amount used, unit costs, etc). Formats for previously defined reports are stored in the reporting section. Other formats are created using the dBase Forms generation help screens. This reduces the complexity of program (and saved us some work).

Another function of this program is the output filter. This takes data from the data base, and restructures it to a form that can be input by other programs, such as word processors, spreadsheet, graphics packages, data base programs, etc. Again, the dBase built-in functions are used to minimize program complexity.

Prediction Algorithm Development and Verification

A variety of methods are available to determine the impact of new buildings on campus annual energy use. ASHRAE Fundamentals, 1985, reviews several methods, including highly sophisticated hour-by-hour modeling methods. Such methods deal with many variables, including envelope gains/losses, effects of lighting, people, equipment operation, etc. No attempt has been made to incorporate such complex modeling techniques in this program.

The hand calculations previously used were based primarily on degree days, and historical square footage data. Most of these procedures have been incorporated into this program. For example, a typical annual electrical use curve is a rough sine wave, and ours is no different. The sine wave, as expected, follows annual weather (degree days) patterns. This seasonal component is factored into the prediction calculation. Allowances are made for buildings under construction, for buildings coming into full use, and for major equipment additions (accelerator physics, biological fume hoods, etc.). A regression module uses historic data to determine the value of seasonal factors, and these factors then determine future use. Recalculating these factors can be done monthly. Adjustments for new loads can be made by manually entering them as stored variables.

The prediction calculations produce reasonable results. The following table compares predicted and actual data for the period of July 1, 1988 to March 31, 1989:

TABLE 1: COMPARISON OF PREDICTED AND ACTUAL UNITS FOR TOTAL CAMPUS DURING FISCAL YEAR 1989

	PREDICTED units	ACTUAL units	ACTUAL - PREDICTED units	ACTUAL - PREDICTED %
ELEC, kWh	64,978,272	65,423,264	444,992	0.7%
GAS, mcf	739,387	760,704	21,317	2.9%
WATER, ccf	484,260	511,747	27,487	5.7%

We are pleased with this year's total predictions. Our current goal is to produce predictions that are within 5% for all utilities, and all components of campus. While we have been successful in predicting campus total units, we have not been as successful in predicting units by component (example, Vet Med electrical actual - predicted = 11.3%). We have been fortunate in that various prediction errors have negated each other.

Future Improvements

Potential improvements include the use of bin hour (temperature frequency) data in place of degree days for reflecting severity of weather (5). Use of bin hours will allow more sophisticated modeling of future equipment, and better predict impact of energy conservation measures.

Another change considered is addition of rainfall data. To date, water use has been relatively flat, but recent improvements to landscape water systems could change this pattern. These improvements could help us bring all component predictions within our goals.

We have ordered an additional computer to increase our record keeping capabilities. Since it will come with a mouse, the software will be modified to accept mouse input. We plan to order dBase IV (1) in the near future. We intend to review the possible advantages of conversion to hand-held bar code data loggers for our meter readers. The meter data would be dumped from the loggers into a temporary file, account numbers would be verified by the existing data entry filter, and the new information appended to the data base.

Conclusions

Even though the present system is useful and flexible, we are trying to resist the temptation to add too many bells and whistles. Recall that part of the logic for Power Plant development of this software was that staff programmers were not available. As other projects are completed, we intend to add this program to the Facilities Management computer. In this way, others are custodians of its future development.

If our program is of interest to you, please contact us and we will provide a copy for your use. We will be happy to discuss it with you and help you get started, but we do not intend to warrant this program, provide updates, or furnish a significant amount of user support.

APPENDIX

1. The following are registered trademarks:

Apple, Macintosh	-- Apple Computer, Inc.
dBase III Plus, dBase IV	-- Ashton-Tate Company
IBM	-- International Business Machines, Inc.
1-2-3	-- Lotus Development Co.
MS-DOS	-- Microsoft Corporation
VisiCalc	-- Visicalc Corp.

2. It seems that all first-time computer users are concerned that their lack of typing skills will cause them to "do something" that will destroy a computer.

3. Random access memory, sometimes referred to as main memory.

4. Lotus spreadsheet capabilities can be enhanced by programs called add-ins. These programs are purchased from vendors other than Lotus, and are attached, or added in, to the 1-2-3 program. Add-ins can add word processing and enhanced graphics. They can also add to the data base capabilities of 1-2-3. It was decided not to pursue this option, because the resulting system is not based on standard products, and machine portability was not assured for the future.

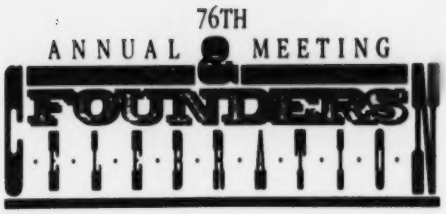
5. Recall that heating degree days (HDD) are defined as:
   65 degF -((daily max temp + daily min temp)/2).

This is an index of weather severity. This definition has been extended to cooling degree days (CDD). HDD and CDD are useful values for quickly comparing severity of weather, but

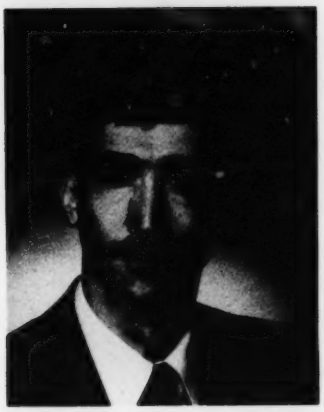
have limitations for predicting utility use in commercial buildings (especially CDD, since they only reflect sensible envelope loads, while total cooling load includes sensible and latent components). Bin hours are an attempt to produce a better weather index. A temperature "bin" is a range of temperatures, usually 5 degF. The number of hours that outside temperature falls within a particular range is the "bin hours" for that temperature range. This information is published by the Air Force, Manual 88029, Engineering Weather Data. A partial listing is shown:

ANNUAL BIN HOURS FOR
FORBES ANGB/TOPEKA, KANSAS

TEMP RANGE	Observation Hours 01 to 08	09 to 16	17 to 24	TOTAL	MEAN COINCIDENT WET BULB TEMP, degF
75/79	129	274	254	657	68
70/74	261	259	285	805	65
65/69	318	219	268	805	61
60/64	285	200	224	709	56
55/59	242	186	205	633	51



Utilities
Distribution Systems



Evaluating Boiler Useful Life for Project Planning

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Historically, the decision to repair or replace a boiler has been based on the age of the unit and a visual inspection. Visual inspections are important, but today, analytical methods are available to determine such things as boiler metal thickness, weld integrity, and changes in metallurgical structure. The utility industry has been using these methods for 6-8 years but smaller central plants have, for the most part, not taken advantage of the technology.

This paper discusses why and how a boiler life study is conducted. Testing methods used in a study are presented showing how they can point to potential failure locations. Three summary case studies show how the boiler evaluations are valuable for project planning. Finally, the cost to perform the studies are compared to major boiler repair and replacement costs.

Why Evaluate Boiler Useful Life

The most important priorities in a boiler operation are (1) safety, (2) reliability and (3) efficiency. These three are closely tied to what most administrators are concerned about, the bottom line. A study of boiler useful life looks primarily at the safety and reliability but also at the efficiency of a boiler. The results of a boiler life study will reveal the condition of a boiler and what repairs, if any, are required for safe, reliable operation. These results can then be used to determine whether to keep and repair an existing unit or consider a complete replacement.

Boiler Life Study Objectives

Three main objectives of a boiler life study are to determine the condition of

1. Boiler pressure parts
2. Boiler trim such as safety valves and water columns
3. Boiler refractory, brickwork, insulation and casing

The pressure parts ultimately determine if the boiler can be operated safely at the given temperatures and pressures. Their condition will also affect the efficiency and reliability of the plant. The condition of components such as safety valves, water columns and their connecting piping are governed by the ASME code and are integral to the safety of the unit. Finally the boiler refractory, brickwork, insulation and casing should be evaluated since they affect the efficiency and proper operation of the boiler.

Visual Inspections (VT)

In determining the condition of the pressure parts, the first step is to conduct a thorough visual inspection (VT) of the unit on both the fireside and the waterside. The visual inspections, as with all testing methods, are conducted by certified technicians.

The internal surfaces are examined for pitting and deposits caused by improper water treatment. Manholes, handholes, nozzles and other connections are examined for any defects or obstructions. The fireside of the tubes and drums are examined for deformation, blistering or bulging.

During the VT, auxiliary items such as safety valves and water columns are inspected. A fiber optic scope (fiberscope) is used for viewing areas such as internal boiler tubes and headers that are not readily accessible. By the time the VT is completed, locations have been identified that require further evaluation and testing.

Ultrasonic Tests (UT)

Extensive metal thickness measurements are taken in the drums and tubes using ultrasonic testing (UT). Ultrasonic methods allow for accurate insitu thickness measurements without requiring access to both sides of the metal. The instruments utilize the pulse echo method of ultrasonics with a direct digital display to the thousands of an inch.

In preparation for taking UT measurements, surfaces are cleaned on one side to bare metal. A grease is then applied to the test spot to give good metal to metal contact with the transducer. A summary of readings from a mud drum is shown in figure 1. It also shows the locations of all the readings and the original material thickness from the manufacturer's data reports. Figure 2 indicates location, and readings of measurements on the drum heads. Thickness measurements were taken on every third tube that was accessible at different elevations. Figure 3 is an example of results from 8 tubes in a furnace water wall.

When taken together, all of the ultrasonic readings give an excellent profile of metal thicknesses. This data is compared to original thicknesses and calculated allowable thicknesses at a given working pressure.

Magnetic Particle (MT) and Dye Penetrant (PT) Tests

Although material thicknesses may be sufficient, the integrity of welds and ligamental areas of the drum tubesheet must be evaluated. The surface of the metal must first be cleaned as was done prior to ultrasonic testing. Dry magnetic particle testing or dye penetrant testing is performed to magnify cracks or stress risers. These cracks may be present due to stress induced fatigue or defects in the welds. Figure 4 shows where testing in the drums are typically conducted. If these tests reveal defects, testing such as ultrasonic shearwave are used for further evaluation.

Metallurgical Tests

All methods described to this point are non-destructive tests (NDT), that is, the tests themselves do not damage or destroy the sample area or the boiler. A tube sample taken from the boiler and sent to a laboratory is a destructive method but a valuable element in determining a boiler's condition. This sample usually consists of an 18 inch long section from a radiant boiler bank. Laboratory examinations look at the crystalline structure of the metal to determine if and how much the tube has been overexposed to heat. Internal and external deposits on the tube surface are also examined in the laboratory. Both the quantity and make-up of these deposits are identified. An overexposed heat transfer surface will usually be accompanied by high internal tube deposits and/or excessive combustion rates.

Infrared Tests (IR)

Infrared testing (IR) of a unit while it is on line can be used to determine if the casing, insulation or brick setting has deteriorated internally. An infrared camera will indicate areas of relatively high heat within the unit. This will be contrasted by areas of relatively lower heat.

For example, a separated refractory wall or deteriorated insulation will show up as a "hot spot" on the camera. Hot spot areas must then be addressed.

The results of these tests give a clear indication of the condition of the boiler. They are compared with the original condition of the unit and with results of any previous tests. An example of this is a plot of the material depletion rate within a boiler drum. Figure 5 shows how such a plot extrapolates an estimated boiler life based on allowable working pressure. Data concerning operation, maintenance and repair of a unit is very important when interpreting the analytical results of a study.

By knowing the condition of the unit, a plan can be developed to repair or replace a unit. Below are brief case studies of three locations in Pennsylvania where boiler plant renovation projects are in progress.

SCI Camp Hill

The State Correctional Institution at Camp Hill is a medium security prison near Harrisburg, Pennsylvania housing up to 2700 inmates. The central steam plant has three stoker fired watertube boilers rated for 250 psi service but operating at 150 psi. Two 600 H.P. boilers scheduled for replacement were manufactured by Keeler and installed in 1938. Since the plant is over 50 years old, many auxiliary systems require major repair or replacement. Initial cost estimates for boiler replacement and pollution control equipment was approximately $2.6 million which equalled the project allocation. Therefore, no auxiliary system improvements would be possible.

Since the replacement boilers were going to be about the same size as the existing units, the decision was made to study their actual condition. A study was completed in June, 1988. Results of the study showed that the pressure parts of the boiler are still adequate for the original rated pressure of 250 psi and that only minor repairs are required. More extensive work is required to repair and replace refractories and leaks in the brick setting. This repair work now amounts to 5 percent of the project allocation. The remaining 95 percent of the money available will be used to update systems such as, coal and ash systems, feedwater treatment, feedwater pumps and deaerator, stoker rebuild, and control systems.

With routine maintenance and proper operation, this plant will be reliable for at least 30 more years. This is significant because these boilers originally had a minimum expected life of 30 years according to state standards. The boilers have not only exceeded this expectancy, but the state can anticipate 30 more years of useful boiler life.

Somerset State Hospital

Somerset State Hospital is a mental health facility located in the Laurel Highlands of Pennsylvania. The central steam plant has three 550 H.P. Riley stoker fired boilers installed in 1950. The boilers have a 200 psi maximum allowable working pressure and operate at 150 psi. This coal fired plant looks immaculate and is superbly maintained. The condition of the boilers reflects the operation and maintenance.

However, a project was initiated to replace one of the boilers due to age. A boiler life study was then conducted to show the actual condition of the boilers. The study revealed that no repairs are required on the boiler pressure parts to maintain the 200 psi working pressure. Minor repairs are required on baffles and refractories. The project will now consist of boiler plant enhancements such as updated control systems, feedwater treatment systems and coal handling systems. It is anticipated that these boilers will be reliable for at least another 40 years.

SCI Retreat

The State Correctional Institution at Retreat is a medium security prison in the Wilkes-Barre Scranton area of Pennsylvania housing approximately 800 inmates. It's central steam plant has three 500 H.P. Keeler CP boilers installed in 1950. They were originally stoker fired, but were converted to oil firing in the late 1960's. The Commonwealth of Pennsylvania has a stated policy to promote the use of coal. Therefore, a decision was made to return to coal firing. Consideration was given to reconversion of existing units because (1) the condition of the the units looked "pretty good", (2) the stoker foundation, framework and some pieces were still remaining and (3) construction of a new emission source burning coal is stricter than reactivation of an existing unit.

The boiler study completed in January, 1989 revealed that minor repairs are required on pressure parts, the setting and refractories. The boilers still have their original 200 psi maximum allowable working pressure. Design has begun to convert two of the units back to coal firing. It is anticipated that these units will have a minimum of 30 to 40 years additional life.

Costs

The cost of a boiler life study is about $5,000 - $6,000. Figure 6 compares this cost to the costs of retubing or completely replacing a unit. In these examples, the cost of a complete replacement is 5 to 15 times greater than a major repair. The needs and economics of each plant must be evaluated, but the cost of an analytical life study is minimal compared to the capital cost of replacement or repair.

One major expense of a new coal fired boiler is the pollution control equipment. A new proposal by the EPA for small boilers (under 100 million BTU/hr input) will significantly increase pollution control costs for new units. Although existing units that are repaired or refurbished must meet current standards, they typically do not have to meet the New Source Performance Standards (NSPS).

Conclusions

As a result of boiler life studies conducted at the three facilities in Pennsylvania, minor repairs will be made to the boilers rather than complete replacements. This will save the state millions of dollars. A boiler life study may yield results similar to the case studies presented herein. The reports can be used as a basis for planning repairs to the boilers. A study may reveal that the drums are safe, but the tubes are potential failure areas. Tubes are considered expendable over the life of a boiler. Therefore, a partial or complete retubing can bring the boiler back to complete reliability. If the study shows that boiler drums are unsafe for long term operation, it can be used to justify new boilers.

For SCI Camp Hill, Somerset State Hospital and SCI Retreat, studies were conducted after project scopes were written and money allocated. However, it is recommended that boiler life studies be conducted as a first step in developing a boiler plant project. By doing so, results of a study can be used as a basis for defining project scope and developing cost estimates for budget requests.

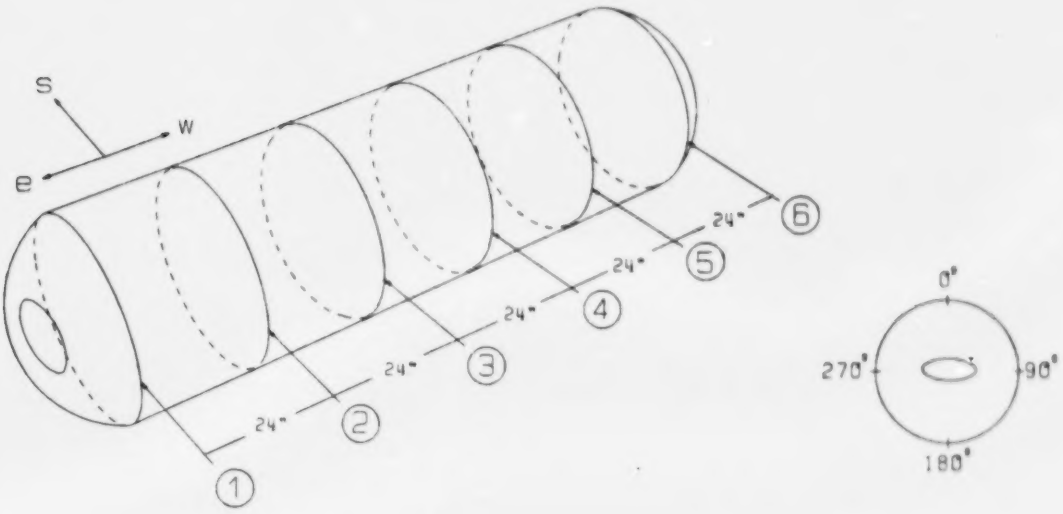
Evaluating the useful life of a boiler has proven to be a valuable tool for immediate and long range planning for central steam plants and should be the first step taken when considering a boiler project.

Figure 1

ULTRASONIC THICKNESS READINGS - DRUM

Boiler 2

DRUM:	TYPE MUD DRUM	Orgnal Thickness	SHELL .737 IN	TUBE SHEET .737 IN	HEADS .719 IN	MFR'S DATA REPORT



LOCATION OF MEASUREMENT	PRESENT READINGS							
	Position	Thickness	Position	Thickness	Position	Thickness	Position	Thickness
1	0°	.825"	90°	.820"	180°	.784"	270°	.789"
2	0°	.835"	90°	.826"	180°	.853"	270°	.822"
3	0°	.813"	90°	.820"	180°	.832"	270°	.816"
4	0°	.825"	90°	.824"	180°	.852"	270°	.840"
5	0°	.860"	90°	.840"	180°	.840"	270°	.829"
6	0°	.849"	90°	.855"	180°	.835"	270°	.839"

NOTES:
Longtudinal Weld at 165°

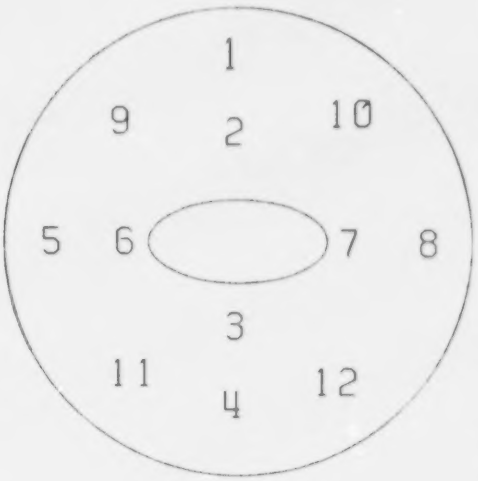
BEST COPY AVAILABLE

Figure 2

ULTRASONIC THICKNESS READINGS - DRUM HEADS

DRUM HEADS	TYPE	HEADS AS VIEWED FROM	ORIGINAL THICKNESS	ORIGINAL THICKNESS PER
	MUD DRUM	INTERNAL, #2 BOILER	.719 IN	MFR'S DATA REPORT

EAST HEAD



THICKNESS READINGS IN INCHES, AS TAKEN AT LOCATIONS INDICATED ON DRAWINGS.

LOCATION

1=	2=	3=	4=	5=	6=	7=	8=	9=	10=	11=	12=
.730	.719	.727	.724	.732	.726	.722	.726	.728	.722	.725	.726

Figure 3

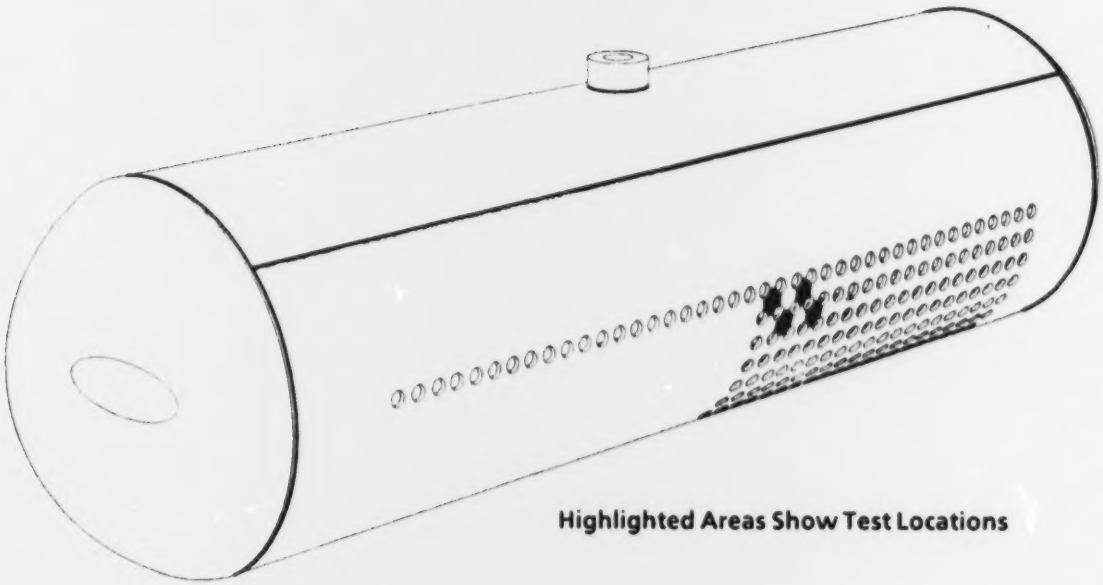
ULTRASONIC THICKNESS MEASUREMENTS - #2 BOILER

Tube #	Elevation			
	4"	4'	8'	12'
3	.127	.121	.121	.125
6	.117	.111	.122	.128
9	.121	.114	.111	.120
12	.118	.116	.112	.124
15	.115	.107	.110	.117
18	.120	.113	.118	.109
21	.109	.103	.117	.120
24	.130	.122	.127	.122

North Waterwall Tubes

2½" OD Generating Tubes
12 Gage (.105") Original Listed Thickness
Tubing Numbering from east to west
Elevations indicated are distances above the waterwall header

Figure 4
TYPICAL LOCATIONS FOR MT AND PT TESTS



Highlighted Areas Show Test Locations

Figure 5

ESTIMATED BOILER USEFUL LIFE

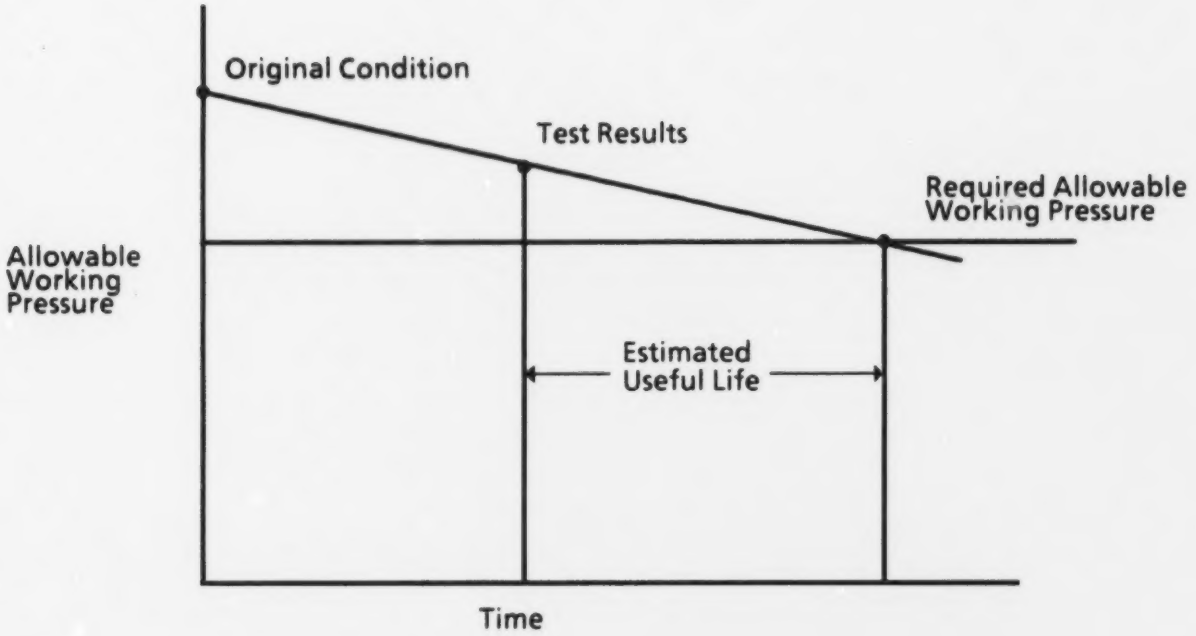


Figure 6

	Cost Comparison		
	500 HP Watertube Coal Fired Brick Setting	500 HP Packaged Watertube Gas/Oil	200 HP Packaged Watertube Gas/Oil
Boiler Life Study	$6,000	$5,000	$5,000
Complete Boiler Retubing	$130,000	$110,000	$65,000
Entirely New Unit In An Existing Plant (see note)	$2,000,000	$600,000	$360,000

Note: These figures are a conservative estimate for comparison only. They include boiler, foundations, pollution control equipment, fans, ductwork, controls, installation and start-up.

Cooling Tower: The Neglected Orphan

Robert Burger
President
Burger and Associates, Inc.

SUMMARY: Loving care is paid to the compressors, condensers, and computer programs of refrigeration systems. When problems arise, operators run around in circles with expensive "fixes", but historically ignore the poor orphan, the cooling tower perched on the roof or located somewhere in the backyard. When the cooling water is too hot, high temperature cut-outs occur and more energy must be provided to the compressors and motors to maintain the refrigeration cycle.

COOLING TOWERS:

(1)...are just as important a link in the chain as the other equipment, (2)...are an important source of energy conservation, (3)...can be big money makers, and (4)...operators should be aware of the potential of maximizing cold water.

Most towers designed over 10 years ago were inefficiently engineered due to cheap power and the "low bidder" syndrome. Operating energy costs were ignored and purchasing criteria was to award the contract to the lowest bidder.

This paper investigates internal elements of typical towers, delineates their functions and shows how to upgrade them in the real world for energy savings and profitability of operation.

A. HISTORICAL NEGLECT

From the very beginning, cooling towers were ignored. Figure 1 is an illustration from the ASHRAE Basic Fundamentals Refrigeration Manual

(1) that delineates a refrigeration cycle consisting of compression, evaporation, expansion, and condensing. The discussion continues on and explains that heat is not generated or destroyed, it is just moved from one location to another. "What is ignored however, is "How is that waste heat dissipated?" As we know, it is picked up by the circulating water and brought to the cooling tower where it is discharged into the atmosphere.

While the cooling tower seems like a simple mechanism, it is just as important to the refrigeration cycle as any of the other units. If the cooling tower does not function properly, high head temperatures require that additional electricity be pumped into the system to make it operate and at a critical point, the equipment will shut the system down if the cooling tower cannot produce sufficient cold water for the equipment.

B. REFRIGERATION ECONOMICS

A cost-effective approach to the solution of conserving energy (and therefore, money) would be to reduce the power input to your system while maintaining maximum efficiency. The power is either purchased from a public utility in the form of electricity or steam, or is generated by the facility by purchasing fuel oil for a diesel engine to power the system.

The following basic principles explain how colder water from the cooling tower conserves energy to create a cost-effective rapid dollar return for cooling tower upgrading expenditures.

Whether it be heat rejection from compressors, electric motor, or chemical process equipment, the cost of "hotter" cooling water is expensive in requiring additional energy to run the equipment at efficient levels to reduce head pressures and temperatures. Excessive heat will create maintenance problems, deteriorate the equipment, and cause shut downs of the process.

A typical example of this is where a refrigerant is cooled (condensed) in the condenser and in turn cools "chilled" water to reduce the temperature of the circulating air throughout the facility to maintain comfortable conditions. Input (electricity or steam) and output (tons of refrigeration) depend upon the speed (rpm) of the compressors and refrigerant temperature (condenser temperature). At any particular speed, both the power requirements and capacities of the refrigeration machine will vary significantly with the refrigerant pressure and temperature. These refrigerant conditions are determined by the cooling in the refrigerant condenser. The quantity and temperature of the condenser water (tower water) determines the available cooling. When operating at full condenser water flow, a reduction in the temperature of the condenser water will reduce refrigerant temperatures and pressures. This will permit producing similar refrigeration capacities at lower machine speeds (rpm) and lower power (steam and electricity requirements.) It can be seen that for various types of refrigeration machinery, colder condensing water off the cooling tower increases the

coefficient of performance. For example, a 5°F reduction to a reciprocating compressor can result in a 7 per cent increase in coefficient of performance. Translating this to dollars and cents, if it cost $250,000.00 to operate the system a year, this 5°F colder water can result in a savings of almost $44,000.00 a year in compressor operating costs since the head temperatures are considerably lowered.

Enthalpy charts for refrigerants indicate that for every degree of colder water to the equipment, a 2½ per cent reduction in energy input can be attained. (3)

If, for example, the refrigeration system utilizes $400,000.00 of electricity per year (typical for a 2,000 ton installation) and a 4°F reduction of cooling tower water is obtained, this will lower the utility bill by $40,000.00 ($400,000.00)(4)(.025). With utility costs soaring, this savings will increase each year.

The facts are readily available in most Operating and Maintenance Departments to determine the cost of energy used, and the reduction in water temperature that can be obtained, indicating the cost savings involved. By comparing the cost savings against the retrofit cost, a payback will usually occur within 6 months to a year and a half depending upon the conditions of the cooling tower before retrofit.

Many authorities point out that lower temperature cooling tower water can produce significant savings for refrigeration equipment. The cooling tower plays one of the key roles in the efficiency of your air conditioning machines. Energy consumption is measured in kilowatt hour usage and this reflects efficiency. If the cooling tower does not create the proper level of heat transfer, your machine will work harder to compensate for the loss and inefficiency (4). Figure 2 clearly indicates that colder condensing temperatures will improve the performance of a compressor significantly. This can result in substantial energy and dollar savings.

The role of the cooling tower is to remove waste heat in the refrigeration or chemical reaction. The degree of elevation of the discharge temperature above ambient conditions is the sum of the tower's approach of the cold water to the Wet Bulb temperature, i.e., the difference between cold water and Wet Bulb, the cooling range (which equals the temperature rise in the heat exchanger), and the terminal difference in the exchanger. A reduction in operating temperature, always desirable for economic reasons, may be obtained by increasing the capability of the cooling tower's performance (5).

C. REAL WORLD PRACTICALITIES

Due to the inaccessible location of the cooling tower (usually installed to conserve real estate on the top of a building, or in the backyard) maintenance personnel are many times hard pressed to adequately service the equipment.

Inadequate training and misplaced priorities tend to keep the operating engineers more closely attuned to the requirements of the compressors, condensers, and evaporators rather than to the quality of cold water being discharged from the cooling tower.

Since the cooling tower is open to the atmosphere, it can quite readily deteriorate due to corrosion of the ferrous parts, and bacteriological and chemical attack of the wood. Many maintenance people feel that if it is ignored, it will go away. But, of course, being familiar with Murphy's Laws - this does not happen.

D. COOLING TOWER MODERNIZATION

A great majority of cooling towers operating today, even though some are newly installed, have been engineered with techniques over 40 years old. Today's technology can be utilized to retrofit practically all towers and upgrade their capability of producing colder water or cooling greater volumes of circulating water (6).

Listed below in ascending order of cost are some of the major components that can be upgraded. It is axiomatic that the greater the dollar input, the more rapid and profitable the return that can be obtained.

1. Air Handling - More air volume results in better thermal transfer and colder discharge water. By pitching the fan blades up to a higher angle, which is determined by the motor plate amperage, additional air can be generated for the same horse power. Velocity regain (VR) Venturi Stacks should be investigated for increasing air flow through the tower while reducing fan motor horse power.

2. Drift Eliminators - Conventional two-pass wood slat herringbone or steel "zig-zag" configurations usually have a higher pressure drop than the new PVC self- extinguishing cellular units, Figure 3. By eliminating the solid droplets of water to a higher degree and at a lower pressure loss, the cellular drift eliminator provides additional cooling air through the tower for colder temperatures.

3. Water Distribution Systems - By installing metered orifice target nozzles in older crossflow towers, a more uniform water pattern is obtained and the resulting uniformity will improve the performance of the towers. Counterflow towers with spray systems can be greatly improved by installing the new square spray ABS practically non-clogging nozzles. Figure 4. An added advantage of this newer type nozzle is that maintenance and cleaning are greatly simplified due to upwards of 75 per cent fewer nozzles required than the conventional small orifice conical pattern spray units.

4. The greatest improvement in the performance modernization is obtained by changing out the old wood splash bars, Figure 6, and by installing state-of-the- art self-extinguishing PVC cellular film fill, together with the new efficient nozzles, Figure 4.

E. EXAMPLES OF UPGRADING

Blow Through Squirrel Cage Tower

The subject three cell metal tower had a water distribution system of 960 small orifice nozzles on 1½" pipe, Figure 5, and was operating at high head temperatures. The clogged and corroded water distribution system was removed from the tower and the rusted clogged steel plate corrugated wet decking fill was also disposed of. After sandblasting and coating with two part catalyzed coal tar epoxy, the new spray system consisting of 36 nozzles on 3" diameter PVC pipes was installed together with new PVC cellular fill.

This chart illustrates the rapid payback for converting the tower, illustrated in Figure 5. Enthalpy charts for Freon indicate that 2½ per cent of the electrical energy to the compressors and condensers can be saved for every 1°F colder water (3). The subject cooling tower was tested in accordance with the Cooling Tower Institute Acceptance Test Code 105 which indicated that 5°F colder water was obtained after retrofit. Since the rebuilding for colder water cost $38,500.00, the return on the investment was realized in approximately 9 months with a projected ten year savings of close to $500,000.00. This payback estimate was generated on the basis of 100 per cent air conditioning utilization per year. If it is realistically cut back 50 per cent for a 6 month's refrigeration operation, the savings still are well worth the rebuilding and upgrading investment.

Crossflow Air-Conditioning Tower

1. The conventional deteriorating wood splash bar slats together with the leaking two-pass herringbone drift eliminators were taken out of the tower and disposed. Figure 6.

2. Cellular drift eliminators and PVC splash bars were installed to obtain higher levels of heat transfer, Figure 7.

3. A new basin lining was also installed, consisting of exterior plywood, polyurethane caulking and 25 to 30 mil of moisture cured urethane coating sprayed to provided monolithic rubber waterproof membrane, Figure 8.

4. Before retrofit, operating records indicated that the 1,250 gallons per minute of circulating water was entering the tower at an average of 100°F, leaving at 90°F, during a 78°F Wet Bulb. After retrofit and certified testing, /7/ the same 1,250 gallons of circulating water was now entering the cooling tower at 95°F, be discharges at 85°F, during a 78°F Wet Bulb. Besides reducing the approach to the Wet Bulb by 5°F, the entire system temperature was reduced by 5°F. This saved the Company approximately $45,000 in electrical costs per year.

5. Inefficient wood fill and leaking drift eliminators were retrofitted with new state of the art self-extinguishing PVC high heat transfer cellular fill and drift eliminators, which reduced the discharge water by 5°F, representing an approximate 600,000 kilowatt hour and $45,000 energy savings 7½¢ KwH utility charge.

Bricks In Your Tower?

1. Prior to upgrading, this V.A. Hospital cooling tower, Figure 9, required two 40 HP motors (80 HP total) to cool 1,800 GPM using ceramic tile bricks as heat transfer media.

The best Approach the tower could produce during Design wet bulb temperature was 8°F.

2. Replacing the bricks with high efficiency PVC cellular film fill and installing 2 new 30 HP motors, the tower was tested in accordance with the Cooling Tower Institute ATC-105 Test Code which indicated the following options:-

Cool 1,800 GPM using a total of only 20 BHP to cool to a 7°F Design Approach.

Cool 1,800 GPM to 4°F approach at design wet bulb using the installed 60 BHP.

Cool 3,600 GPM (double the waterflow capacity) to 7°F design approach during design wet bulb of 78°F with a 50 BHP power consumption.

The cost of the conversion was paid back within 14 months due to the colder water on the compressors and less BHP fan requirements.

F. CONCLUSION

If a refrigeration/air conditioning system is operating marginally due to high head temperatures, it behooves the owner and operator to investigate the possibility of upgrading the existing cooling tower rather than installing another O.E.M. unit, which may or may not solve the problem of producing colder water. It should be well understood that colder water can save energy and create an operating profit. Cooling towers are hidden bonanzas for energy conservation and dollar savings when properly engineered and maintained. In many cases the limiting factor is the quality and quantity of cold water coming off the cooling tower /8/.

The thermal upgrading and structural retrofit technology of all types of cooling towers is the same, only the size is different, as illustrated in Figure 9.

It would be prudent for the engineer with responsibility for the efficient operation of the refrigeration/air conditioning system to have a professional inspection of the cooling tower by a consultant who can analyze the energy savings potential of his installation. In these days of high energy costs, the savings accrued from a well engineered and retrofitted cooling tower, bringing it into the 1980's, can make a significant impact on a Company's profit and loss statement.

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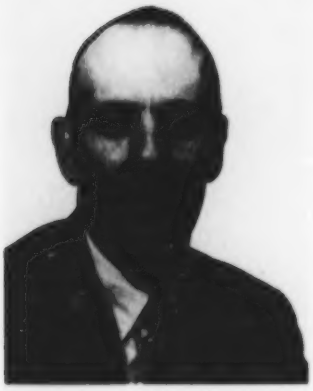
6. Robert Burger, "Cooling Tower Technology", Chapter 8, (1979)

7. Dallas Texas College, test report upon request.

8. Lilly-Hoffman, "Cooling Tower Operations", Cooling Tower Institute Proceedings, (1980).



Free Cooling: How and Why

Michael J. Dwyer, Jr.
Executive Director of Campus Operations
University of Arkansas for Medical Sciences

Background

The University of Arkansas for Medical Sciences campus is located in a residential section in the City of Little Rock in what is considered the Sunbelt region of the South Central United States. The main campus is situated on a 26 acre block and consists of 11 major buildings totalling over 1.25 million square feet.

Steam and chilled water are generated in a central power plant and distributed to all but one building on campus. The power plant contains one 750-ton steam driven turban chiller, one 900-ton centrifugal chiller, and one 2,500-ton centrifugal chiller. The campus was constructed in 1956 and initially consisted of a 350 bed hospital, a nine story educational building, and a ten story student union building. Additional educational buildings, research buildings, and outpatient clinic facilities have been added.

Over the years numerous renovation projects have taken place, primarily to convert former teaching space into research laboratories and animal holding areas. As research became more complex and more heat generating equipment was installed (both in the hospital and research buildings), it became necessary to provide chilled water to many locations on the campus year round. This was true even though the outside air temperatures were below freezing for a number of days at a time. To produce chilled water under these conditions modifications to the chiller were required in order to make sure it would not unload itself to the point where it would shut down.

In 1975 the 2,500-ton centrifugal chiller was installed and all steam absorption chillers were phased out. It was thought at that time that over the next few years the cost of electrically generated chilled water would be cheaper than gas. During the summer months (especially when the temperature is above 95 degrees) it is necessary to maintain 41 to 42 degree chilled water in order to provide adequate cooling to the operating room and labor

and delivery. As the outside temperature decreases, the chilled water temperature is allowed to rise to approximately 45 degrees during the day and up to 48 to 49 degrees at night and on weekends when many of the critical areas are not in use. Table 1 indicates the climatological data for the four winter months.

Temperature (Degrees Fahrenheit)	Nov.	Dec.	Jan.	Feb.
Average Daily	49.7	42.4	40.2	47.1
Average Maximum	56.7	50.0	49.3	55.9
Average Minimum	42.6	34.7	31.0	38.3
Degree Days				
Heating	454	694	762	496
Cooling	0	0	0	0

TABLE 1 TEMPERATURE AVERAGES FOR A FOUR MONTH PERIOD

FREE COOLING

Although there is a clear cut definition of free cooling, to me free cooling means cooling without the use of mechanical refrigeration. In reality there is no such thing as free cooling. By that I mean we cannot cool without some cost. Because even if we are not using refrigeration, we will still have to move air some way and probably some type of cooling liquid, both of which cost money. However, if you are doing the cooling without the use of mechanical refrigeration you have taken the biggest energy user out of the system (compressor, or chilled water pump, or solution pump, or boiler in the case of an absorption machine).

Let's talk about some of the different methods of what I consider free cooling. You've all heard of the kiss method, to keep it simple. The earliest method known to man as free cooling was simple - open the window. Well as we know, many buildings now days don't even have windows that will open and if they did, most administrations don't want people opening the windows at random. In health care institutions it may even be against code to open windows in certain areas.

Probably the most used method of free cooling is the economizer cycle. This cycle is accomplished through the use of some sort of air handling unit or air handling equipment and is quite common. Here an air handling unit is used that is delivering air to the space. The equipment needed for this system would be some sort of outside air mixing box or a way to bring in outside air. The other requirement is having some sort of economizer controls.

Another type of system that you may have is a unit ventilator system which also may have an economizer cycle. Quite often, a variation is an economizer controllable lockout of there refrigeration or chilled water coil so that while your doing your free cooling you won't also be doing mechanical cooling.

Other types of free cooling involve the use of a previously installed chilled water system in one form or another. I think there really are three different types of free cooling (using the existing system) two of which I will describe briefly and the third is the subject of this paper. Basically, all three use the principle of heat exchange in that one side of the heat exchanger is connected to the existing cooling tower system and the other side to the

chilled water system. For these systems to operate, the outside air must be low enough so the cooling tower water (which usually operates in the 75 to 85 degree range) can be lowered to approximately 45 degrees or a fixed temperature that has a direct relationship to the required chilled water temperature. At this time, the cooling tower water becomes colder than the building system's chilled water and, therefore, heat will be exchanged from the building to the cooling tower water. The simplest system to install uses an existing chiller as a heat exchanger and its refrigerant as the actual heat transfer medium. There is minimum renovation required to the chiller and none required to the existing piping system, either in the chilled water side or the cooling tower side. Thus, it is also by far the cheapest to implement. However, there are certain disadvantages: the first being that this system will only generate 35-40 percent of the tonnage available from the chiller when it is operated manually, i.e., when it is a 1,000 ton chiller it will provide 350 to 400 tons of cooling. The other disadvantage and probably most significant, depending on the area of the country in which the facility is located, is that the chilled water can only be cooled to about 10 degrees above the temperature of the cooling tower. Of course, in northern climates where temperatures remain below 40 degrees for long periods of time, this is not a disadvantage.

The second free cooling system is called the strainer cycle (see Figures 1 & 2 below). This cycle once again works with a cooling tower and chilled water systems. In effect, it allows the cooling tower water to enter the chilled water system through a strainer. Obviously, when you inject cooling tower water, which is relatively dirty, directly into the chilled water you can sludge up a cooling system very quickly. For this reason, strainers and filters are added to prevent dirt from entering the chilled water system. This method also has some disadvantages. The strainers take up a large amount of room in the boiler house and need to be located somewhere close to the existing chiller. Another problem is that you have to clean the strainer on a regular basis. The newer systems have an automatic backwash system that would operate approximately every hour during the initial system clean-up. But once this was completed, the backwash would occur only once or twice a day. When you are backwashing strainers, you have to dispose of the water down the drain and as a result your building's water usage goes up. A major advantage of this system over the use of the chiller is that if you have 40 degree water coming from the tower, you have 40 degree water in your chiller water system.Therefore, this system can be operated many more hours per year than the previously described system.

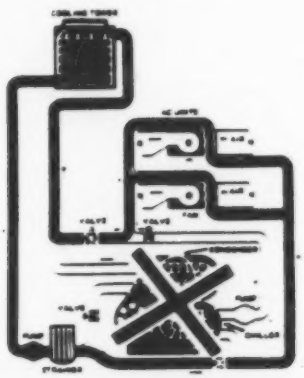


FIGURE 1 WATER FLOW IN STRAINERCYCLE

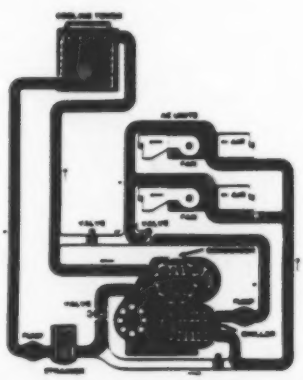


FIGURE 2 WATER FLOW IN NORMAL CYCLE

The third system is a combination of the first two and involves a flat heat exchanger that allows heat to transfer directly form the chilled water system to the cooling tower system. Thus, it is possible to generate chilled water that is only one to two degrees warmer than the cooling tower, but does not run the risk of contaminating the system and actually takes up less space than the equipment needed for the strainer cycle. However, it does require the additional piping and valves that the strainer requires so its initial cost is about the same as the strainer but a lot more than the chiller (about $100,000). The actual energy savings and payback period will vary greatly, depending on the system used as well as the temperature variations experienced in the area.

OPERATION

During the first cycle of the Hospital and Colleges Energy Grant program, the University of Arkansas for Medical Sciences modified its 2,500 ton York centrifugal chiller for free cooling. The total cost for this modification was approximately $35,000. Thus, it cost the University half this amount under the matching funds grant program. As predicted, we are only able to get about one-third the rated tonnage of the chiller (750 tons) during the free cooling mode. However, tonnage-wise this was enough to meet the needs of the campus during the cold winter days. More significant was the fact that there was more than a 10 degree loss between the cooling tower water and the chilled water during the free cooling process as shown in Table 2.

Free Cooling Chiller Temperatures

Time	Outside	Cooling Tower	Chilled Water
0600	38	40	51
1200	39	36	47
1800	36	35	47
2400	33		
0600	31	37	48
1200	35	39	50
1800	35	40	50
2400	33	40	51
0600	34	38	48

TABLE 2 TEMPERATURES DURING FREE COOLING PROCESS

Because of the winter temperatures found in the Little Rock area, this 10 degree change significantly reduced the number of hours that free cooling could be used and in many cases limited free cooling to evening hours. A greater problem, however, was that of freezing of the cooling tower itself. The cooling tower fan was temperature controlled and automatically shut off when the cooling tower water got below 45 degrees, however at about 30 degrees ice started to form on outer edges of the tower. It was felt that major damage could occur if this ice was allowed to build up for any significant length of time. Strange as it may sound, as the temperatures decreased we were forced to turn the chiller back on in order to heat up the condenser water. Although successful during hours of operation, this type of free cooling was limited by both an upper and lower temperature range. A review of the daily temperature ranges in the Little Rock area indicated that free cooling would be extremely beneficial if it was not limited by lower temperatures and a method could be devised by which there is a minimum Delta T between the cooling tower water and the chilled water. An efficient heat exchanger would meet these requirements if

at the same time modifications could be made to the cooling tower to allow it to operate at lower outside temperatures with out the problem of freezing. A flat plate heat exchanger can be installed in a manner very similar to that of a strainer cycle as far as the amount of additional piping and valves is concerned; the difference being the heat transfer takes place in the heat exchanger rather than in the building itself (see Figure 3).

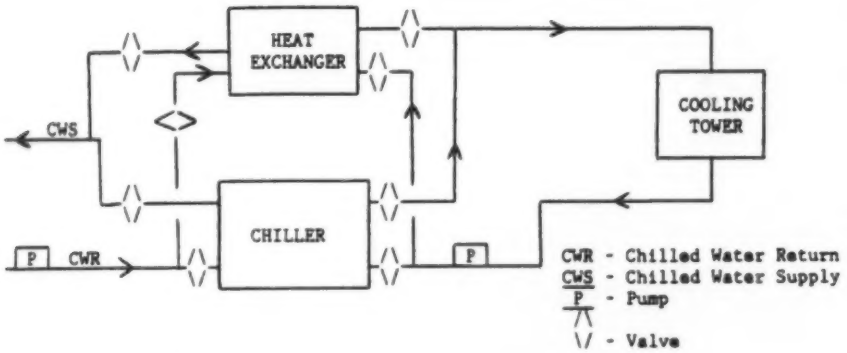


FIGURE 3 HEAT TRANSFER IN HEAT EXCHANGER

Because there was no other flat plate heat exchanger system in the state of Arkansas, the State Energy Department determined that such a system could be installed on an experimental basis and energy funds could pay for the whole project, in contrast to the energy grant program which is normally a 50/50 match. A Traenter Model UX-896-UP-335 Flat Plate Heat Exchanger was installed in the central power plant adjacent to the 900 centrifugal chiller. It was recommended that the flow rate of the chilled water be as close as possible to the condenser water flow for the system to achieve maximum efficiency. In our case, the system was designated for 4,490 gallons per minute of chilled water and 4,400 per minute of condenser water flow. It was estimated that this system could achieve chilled water temperatures range between 44 degrees and 49 degrees with condenser water temperatures of 42 degrees and 46 degrees. Table 3 shown below is an example of what was actually achieved on two separate days.

Free Cooling Flat Plate

Time	Outside	Cooling Tower	Chilled Water
0600	38	46	47
1200	40	45	48
1800	41	45	48
2400	38	46	45
0600	33	44	43
1200	48	44	49

TABLE 3 TEMPERATURE RANGE WITH CONDENSER WATER TEMPERATURES OF 42 AND 46 DEGREES

In order to solve the cooling tower freezing problem, heat was added to the tower basin and the cooling tower fan, motor and drive were modified so that the fan could reverse direction when necessary. When ice begins to form the fan is reversed (run backwards) until the tower thaws out.

It was hoped that the heat exchanger installation would be completed in time to use it during a complete winter season. Late equipment deliveries delayed completion of the project until late January, so the first year there was only one month of actual use.

Table 4 indicates the number of days in which free cooling was used during the four coldest months (November, December, January and February). The old free cooling system (the 2,500 ton chiller) was used in the first three months and the flat plate heat exchanger was only used in February. December was the coldest month of the year with January and February temperatures being way above the norm.

	Free Cooling			
	Chiller		Flat Plate Heat Exchanger	
Month	Days	Hours	Days	Hours
Nov	2	28		
Dec	15	246		
Jan	12	118		
Feb			8	128

TABLE 4 DAYS IN WHICH FREE COOLING WAS USED

Table 5 indicates the outside temperatures and chilled water temperatures during four days in which the flat heat exchanger system was used continually. These days were all week days and it is obvious from the maximum temperatures that the chiller free cooling system could not have been used during a major portion of the daylight hours. A chiller was turned on at about 10:00 a.m. on the 21st when the outside temperature finally reached 51 degrees and the chilled water temperature was at 48 degrees. For every hour the flat plate heat exchanger is on, the medical sciences center realizes a savings of $30.93. Therefore, during the period described above, there was a total of 128 hours of free cooling for a savings of $3,959.20. Using the actual experience of late February and the climatic data for the months of November, December, January and February, it appears that it would have been possible to use the flat plate heat exchanger for a total of 1,435 hours at a savings of $30.90 an hour, which would equate to an annual savings of $44,384. In energy this would amount to 986,366 KWH. The cost figures above are based on an average cost of electricity or .045 per KWH. It is anticipated that once a full year of data is available and we can show the number of hours which we will not have to operate one of our chillers, we can also realize additional savings by obtaining a reduction in the cost of our chiller maintenance contracts.

	Temperatures					
	Outside		Cooling Tower		Chilled Water	
Date	Max.	Min.	Max.	Min.	Max.	Min.
17	36	30	43	41	146	44
18	45	32				
19	42	37				
20	42	37	46	43	49	43

TABLE 5 TEMPERATURES DURING CONTINUAL USE OF FLAT PLATE HEAT EXCHANGE SYSTEM

Now for the bad news. There was one serious problem incurred in operation of the free cooling system that has since been corrected. Operation of the type chiller installed on the UAMS campus was limited to cooling tower water of no less than 65 degrees. Therefore, prior to putting the free cooling system into effect, there was a period of time after the chiller was shut down before the cooling tower water was cold enough to implement free cooling. This period of time ranged from 10 minutes to 30 minutes, depending on the outside temperature. Of course, since free cooling was implemented at the highest outside temperature possible, it normally took 30 minutes for the cooling tower to reach the mid 40 degree range necessary to switch to free cooling. This period of time without any cooling at all resulted in unacceptable temperatures in many areas of the facility. The problem was solved by using the free cooling of the 2,500 ton chiller, starting approximately 15 minutes before the switch to the flat plate heat exchanger and carrying over 15 minutes afterward. This was enough to keep the chilled water at an acceptable level. Modifications have since been made to the 900 ton chiller (normally run in the winter prior to use of free cooling) that will allow passing a controlled amount of the tower water, therefore allowing the chiller to operate at a much lower water temperature. We now have an additional year of operational experience with our flat plate heat exchanger and are extremely pleased with the results. Table 6 indicates the results of operation from November 1987 to March 1988. The average outside temperatures for this year have been 2.8 degrees greater than the last year. Table 6 does not indicate any free cooling on our large York chiller although it was used as an aid in starting our flat plate heat exchanger operation.

	Free Cooling				
	Chiller		Average Outside Temperature	Flat Plate Heat Exchanger	
Month	Days	Hours		Days	Hours
Nov			55.45		
Dec			46.62	22.21	533
Jan			38.53	22.54	541
Feb			45.15	9.08	218
Mar			54.57	.33	8
			.00	54.17	1,300

TABLE 6 FREE COOLING OPERATION RESULTS

The 1,300 hours of operation of the heat exchanger equate to an annual savings of $40,265 based on the average cost of electricity at .046 per KWH. This is actually less than last year's prediction of $44,480 but this can be attributed to the fact that we did not have as cold a winter.

With additional hours of operations, we did uncover another problem that we are in the process of solving. The cooling tower we are using with the flat plate heat exchanger has two cells. When we installed the flat plate heat exchanger we also installed not only base heat but the capacity to reverse the fan in one cell of the cooling tower. There was enough water carried over to the other cell to cause an icing problem so we decided to have the second cell fan designed to have reverse operation.

Again, there is no doubt that the installation of the flat plate heat exchanger has realized significant monetary savings for the University of Arkansas for Medical Sciences campus. We also have experienced continual free cooling operation using a greater tower water temperature than anticipated. On cloudy days we have been able to maintain free cooling with tower water temperatures as high as 48 to 50 degrees.

We are currently installing an additional chiller in the central power plant in order to handle the increased demand resulting from the construction of the Arkansas Cancer Research building. As a result of the experiences we have had in the past, we are also including a flat plate heat exchanger in the installation of this new chiller. We are extremely anxious to try out our new chiller and flat plate heat exchanger and to develop new procedures that will allow us to use combinations of chillers and flat plate heat exchangers depending on the weather and the demands on the system.

CONCLUSION

In most parts of the country free cooling can achieve significant savings in both energy and dollars. Of course, the actual amount of savings will depend on not only the temperature encountered at a particular location installation but also the amount of cooling needed by the facility during the winter months. With more and more complex computer equipment being installed in hospitals and medical centers, the need for year-round cooling is on the increase. Although not absolutely free, free cooling should be investigated by all plant engineers as a means to reduce escalating costs in both operating and utility budgets.

Swistock

Utilities Infrastructure Development at a Major Research University

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Some of the more difficult challenges facing University Physical Plant managers today are in the area of utilities support for academic research facilities, especially those concerned with life sciences and medical sciences.

These challenges have two major elements. The first is dealing with an aging utilities infrastructure that is likely decades old, probably operating at full capacity with something less than high dependability and in many cases unable to provide the service demanded. The second major element of the utilities challenge is being able to meet the exacting demands of sophisticated research. In addition to high quality and dependable electric power, precise space temperature and humidity requirements, elaborate alarming and remote monitoring requirements have become common.

The details of the problems associated with the aging utilities infrastructure vary from campus to campus, but the basic problems are common. Many utility systems on campuses were installed in the 1950's and 60's and were adequate to meet the demands of the time with, in many cases, a significant amount of reserved capacity; however, construction in-fills and renovations have frequently used all the available capacity. In many cases there was little incentive to develop efficient utility delivery systems and there was little need for precise environmental control in laboratories. It was not uncommon for steam systems of 40 years ago not to have effective condensate returns, and where condensate return systems existed, many were allowed to deteriorate until they were essentially useless. This was, to

a large extent, acceptable since energy was relatively inexpensive and plentiful and natural gas and oil boilers in the basement replaced many steam and hot water distribution systems. Until the 1970's electricity was cheap and becoming more and more dependable. Therefore, campus electrical distribution systems frequently were not upgraded and expanded to meet demands and new service drops from the local utility companies became a cost effective alternative.

Today with relatively high energy costs and demand charges being a part of most electrical rates, what was a cost effective solution to energy problems in the 50's and 60's has been an extremely expensive way of providing utilities.

More difficult to deal with is the question of providing adequate quality of utility services to research facilities. Today's buildings, especially research facilities, require more reliable, more closely controlled utilities than was generally the case in the past. Today, we must deal with multiple demand variables on a micro-scale. In short, today's utilities systems absolutely must be of the same quality and sophistication as the research facilities they support. The best way to achieve this, I would suggest, is through the development of large utilities infrastructure systems conceived with a true systems engineering approach, which we have called a "single system concept". In this concept, the single utility system extends from the point of generation or purchase to the individual end user; i.e. the individual laboratory, and does not recognize the traditional separation between distribution system and building system at five foot line or building entrance vault. In a large research building or complex, this reflects the researcher's perception of the utility system and is consistent with our on-going effort to develop the capability to monitor, control and alarm utilities at the point of consumption. This capability to control functions within individual laboratories is what researchers are demanding. This approach permits the end-user to receive the technical benefits of system scale, in terms of redundancy, system inertia and sophisticated control, while at the same time providing the political benefit of separating the development needs of the utilities infrastructure from the specific demand associated with an individual project. Let me explain: in years past we have accomplished a myriad of research facility renovation projects and a smaller number of new research construction projects. The great majority of these have been funded from sources such as research grants, and other specific program funds. While the utility needs of each of these may have been intense in terms of quantity and quality, most often no single project or even group of projects was of sufficient magnitude to bear the cost of upgrading the entire utility system of even a single whole building, let alone a campus precinct. Moreover, given the nature of the funding, i.e.

single purpose, it is probably not appropriate that any one project be expected to do so. The result has been a piecemeal, ad hoc approach to the problem, which gives us major research buildings with perhaps six different cooling systems--some operating year round, some not, equipment on the roof and in flower beds, not to mention the window units gracing architecturally significant buildings; vents from laboratory hoods all over the roof--often sighted without consideration of prevailing winds and air intake locations; multiple emergency generators serving different laboratories, and all, of course, with no centralized control of environmental conditions or monitoring of power status. I'm sure I don't have to tell you horror stories; most of you will have your own.

The starting point for a solution is a utilities master plan. I would suggest that what is needed here is something more than a traditional inventory of existing conditions and logical scheme for upgrading and extending systems. It seems to me that the need is for a probabalistic assessment of a spectrum of best case to worst case demand growth scenario, to ensure the infrastructure is which we invest will not be rendered obsolete a few years down the road by a relatively minor shift in research direction. The approach to be avoided is making system decisions based on a specific set of basic development assumptions. A case in point is the sizing of chilled water distribution lines: a centrally controlled chilled water production facility can take the form of large chillers located in different buildings, however, the first section of the "loop" which connects these chillers constrains the future design of the entire system. It is equally obvious that one can't afford to build in great excess capacity which will never be used. The task is to design for flexibility and expendability through planned multiple paths and the use of computerized controls. The important thing is to think about this during the early planning stages.

The mechanics of this planning approach are relatively simple: computer programs are available with mathematically model conditions in all parts of the utilities distribution system under varying operational circumstances. I know you are all familiar with hydraulic models of domestic water systems which provide predictions of fire flows under different operational conditions. The same approach can be used for chilled water, medium or high temperature water, steam and electric power to allow planners to play "what-if" games with alternative campus development schemes. Moreover, this approach can be used within a single research facility if the complexity warrants the effort.

The key here is that this is not a one time drill where demand projections are established and then carved in stone. Once the program is tailored to your institution's utilities infrastructure, it must be retained by the department or the

university's engineering consultants. Then as physical facilities and development plans change over time the model can be re-irritated and the "what-if" games replayed. This makes utilities infrastructure planning a dynamic and responsive process that puts utility managers ahead of the demand curve.

The political aspects of the single system approach are perhaps as important as technical ones. Having in hand a utilities master plan, which shows where we want to go, and a utilities infrastructure development program, which is a logical sequence of individual projects which will meet the immediate short term needs of individual projects by constructing increments of the utilities master plan, we still have to find a way to pay for it all. This is the political part: with a program that benefits all in general that no individual or department exclusively where do you find a sponsor? Of course every institution, public or private has a means of providing for traditional capital outlay projects. This systems usually provides authority for capital projects and frequently provides funding for the projects. The system is usually a highly political and visible one in which popular projects are favored. A library, research building or other highly visible projects will usually enjoy considerably more support than a steam tunnel or electrical distribution system. However, utility projects should be funded through this process whenever possible. The fact remains, however, that it is much easier to obtain funding for a facility that can become a visual memorial to one of the institution's benefactors. There are very few high temperature hot water lines or other utility systems that carry the name of a school benefactor.

While a new wing for a research building can usually find funding, how do you fund the additional capacity for the utility systems that will serve this new facility? The answer is, you don't, in the traditional sense. You do what a combined utility company and landlord would do; you charge the individual research laboratories or departments for utilities on the basis of quantity consumed. These charges are based on rates which include all costs of purchase or production, including operations, maintenance, minor improvements, equipment replacement and overhead. Remember, all of these costs are currently being paid for someone. Apportioning cost to users on basis of consumption adds nothing to the bottom line totals of system costs. When a renovations or new construction project brings a new customer with added demands to the system, the project should pay a "connection fee" roughly equivalent to the cost of providing the utility--chilled water for example by a stand-alone system. The has an equity basis that is familiar to funding agencies: the fair price to acquire a service is equivalent to the cost to acquire that service at some nominal commercial location. In addition to providing a rational means to

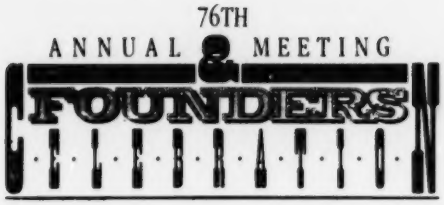
address costs, this approach has the perception of benefits shifting from the general to specific. The researcher who is unwilling to contribute to even a design of a common use system can readily accept the fact that he will have to pay so many dollars to provide chilled water to cool his equipment or his spaces.

Major cost avoidances are available in terms of demand billing for electric power, providing steam or hot water from coal burning heating plans, reduced maintenance and operating costs of single large systems, the provision of effective redundancy through load diversity among users without having to physically duplicate critical equipment components, and through the ability--using sophisticated control systems--to accurately and effectively match system demands with system production. Non-financial benefits are obvious to the individual consumer: increased reliability through component redundancy, enhanced quality to system inertia and sophisticated centralized control and the ability to alarm virtually any condition within a laboratory.

The advantages, exploited through life cycle cost analysis usually show that capitalization of the "backbone" infrastructure is cost effective. Once capitalized through a line of credit, bond issue or other means, funds must be generated through rate surcharges and connection fees to service and amortize the debt. A major portion, if not all of this debt will be off-set over the life of the system by cost avoidances resulting from the large and more efficient systems.

A key point here is the need to do one's fiscal homework before presenting this approach to your institution's financial officers. You must know your current demand and total actual cost of each utility service to establish the base line for all the financial projections necessary to get support for this program.

Properly accomplished, this approach can put utility managers in the lead in the research environment and ensure that we no longer have to play catch-up ball or provide less than the best utility services to our institutions.



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